Gas Journal

VOL. 293. 110th YEAR. LONDON, FEBRUARY 12, 1958 Nº 4935 PRICE 1/6

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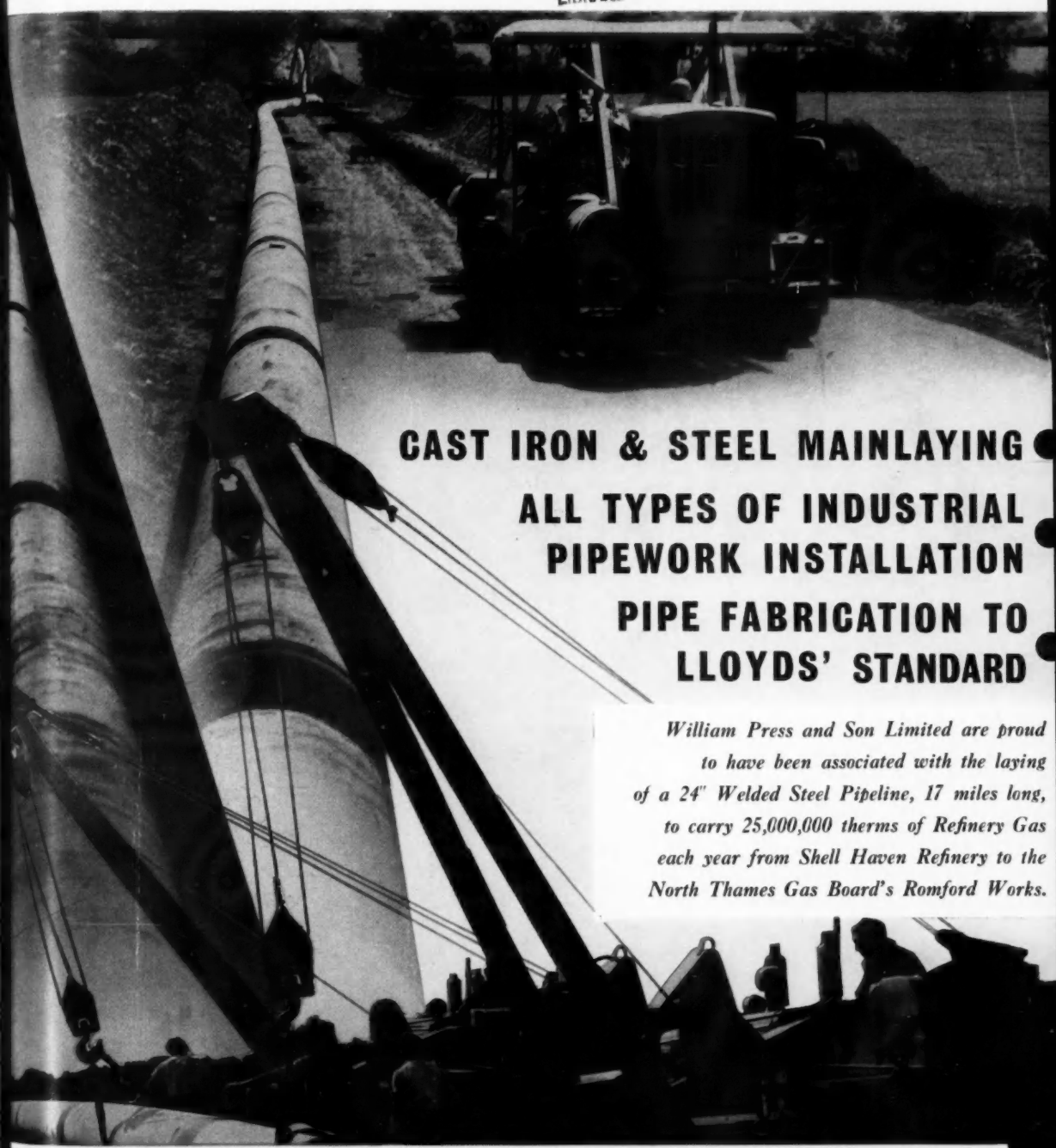

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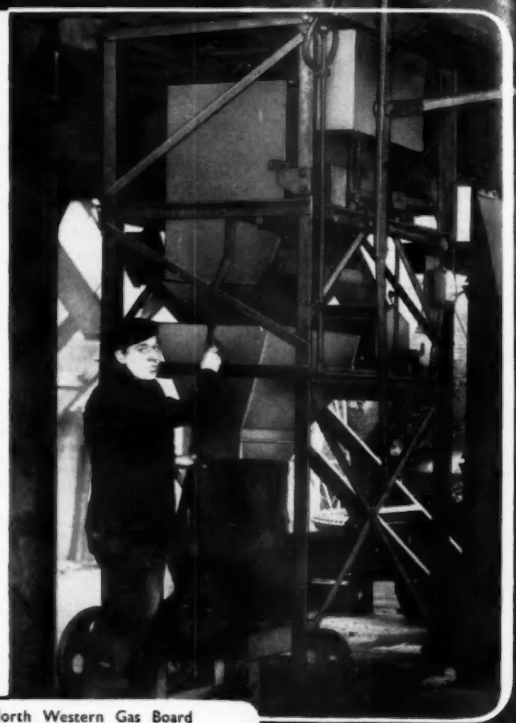

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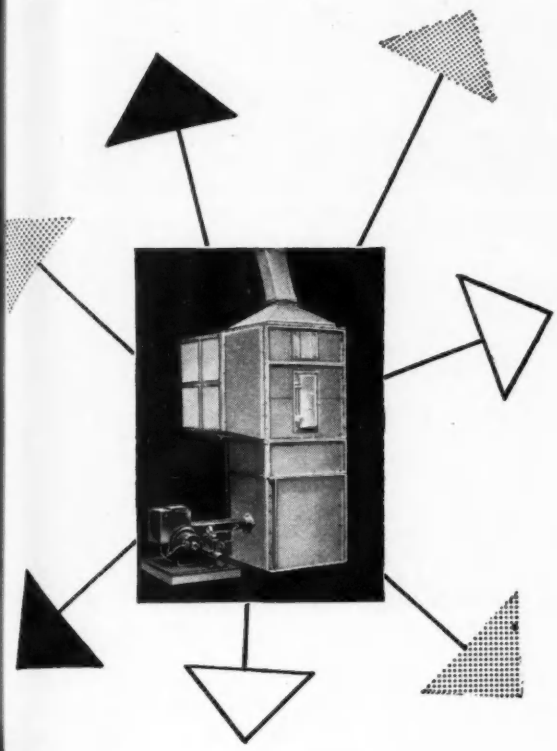

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Gas Journal

VOL. 293 NO. 4935 February 12, 1958

110TH YEAR

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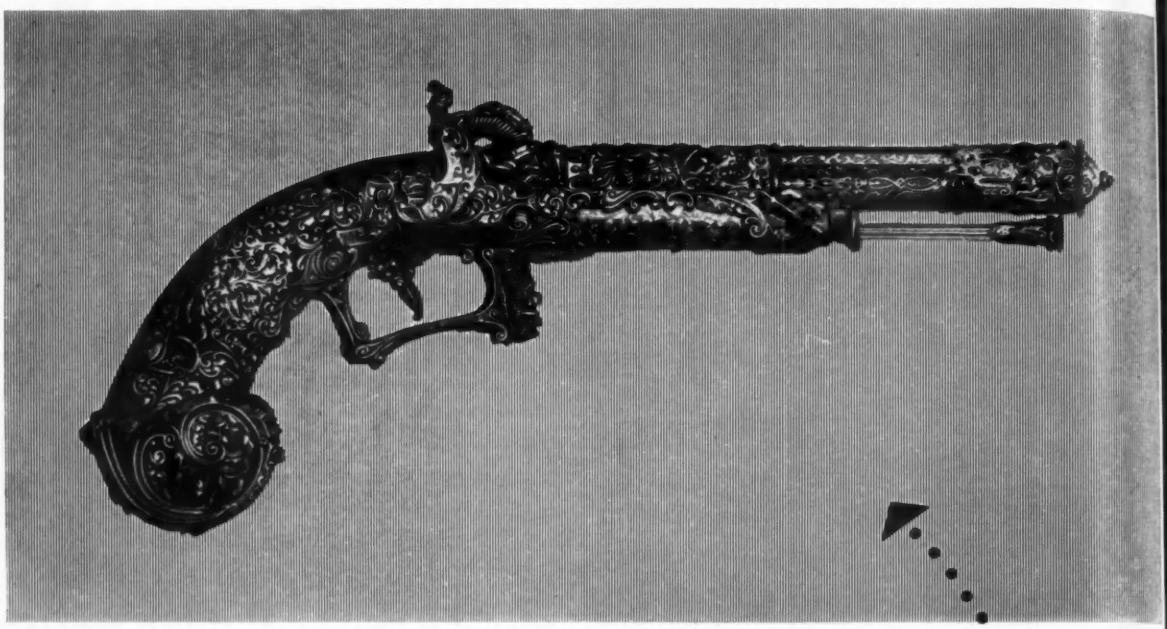

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something in common

They remind one of different worlds, the Spanish forged iron pistol of 1850 and the modern T.G. meter. Yet, they have something in common — both are the products of true craftsmanship. The pistol delicately engraved and inlaid with damascene, designed and made by Eusebio Zuloago of Madrid, is presented as a fine example of the gunsmith's skill. The T.G. meter epitomizes craftsmanship and the T.G. 'G' prepayment mechanism is accepted as the most modern precision movement on the market.
Something else in common, this Spanish pistol and a T.G. meter were both exhibited at the Great Exhibition of 1851.

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Gas Journal

VOLUME 293. No. 4935. FEBRUARY 12, 1958. 110th YEAR

The Thin End of the Wedge

LORD MILLS, Minister of Power, has decided to set up 'a committee to consider ways of improving co-operation between the electricity and area gas boards in the performance of their respective statutory functions and in the administration of the services of a like kind provided for the public by the two industries.'

Before he announced this to the Lords in a debate initiated by Lord Macdonald of Gwaenysgor, he said that the competition between the gas and electricity industries, which was quite strong in some areas, had attracted a considerable volume of criticism. It was felt by the critics that there was an obvious and avoidable duplication in the distribution services, with showrooms presenting the claims of each industry in the town. Advisers had looked at the matter before and had come to the conclusion that there was nothing in it, but he had decided the time had arrived when it might usefully be looked at again.

When he was asked by Lord Greenhill if the inquiry would include scrutiny of the amount of money spent in 'unnecessary advertising,' Lord Mills said that would all come into it. And so, he told Lord Latham, would meter reading and sales of appliances. The committee, he said, would include full and part-time representatives of the two industries, with independent members and an independent chairman.

We regard this news with considerable misgivings. The fact is that the nationalised gas industry has always appeared reluctant to give serious consideration to sharing facilities and services. And equally there has been little evidence of eagerness on the part of the electricity industry. That some functions, such as meter reading and possibly billing, might be performed jointly with a considerable saving can hardly be denied. There were plenty of examples of this in pre-nationalisation days and the practice is quite common abroad today. To argue, as many have, that the expense of rearranging accounting facilities, etc., would more than offset any saving obtained is short-sighted; in the long run savings would be inevitable. But—and this is the vital point—where should the line be drawn? To what extent can the two industries merge their operation without destroying the precious and necessary competition which is the very essence of good service to the consumer? We believe it is the fear that any sharing of services would prove to be the thin end of the wedge, gradually leading to the undesirable creation of a monopoly, which has discouraged joint services in the past.

Let us look at the matter from the customer's point of view. Both the gas and electricity industries are public servants and as such should place the convenience and satisfaction of their customers above all else. To what extent would those customers benefit by a partial merging of the two industries? It can hardly be denied that having one man call to read both meters would save the consumer trouble, and so would the presentation of one bill instead of two. But neither of these duties is truly related to the competition which exists between the two industries. As we have said, it is this competition which protects the consumer against the evils of monopoly and keeps both industries on their toes. We noted that Mr. Maudling said competition must continue to be the basic principle of the co-ordination of our fuel policy, when he spoke in the recent debate on the gas and electricity industries. Mrs. Jones might imagine that it would save her trouble if gas and electric appliances could be seen at the same showroom. In practice, however, this advantage would be offset by the inevitable loss of interest and eagerness on the part of a salesman responsible for selling appliances burning either fuel. And surely nobody seriously visualises a showroom with representatives of both industries working side by side!

A great deal of fuss is made about gas and electric expenditure on advertising; Lord Greenhill's reference to 'unnecessary advertising' is typical of this critical attitude. Yet it is this advertising which helps to keep the consumer informed of new developments and encourages higher standards and the use of more efficient appliances. Advertising is an essential part of the whole business of giving the consumer better service by helping to sharpen the spur of competition. Expenditure on advertising (particularly in the case of gas) is nothing like so great as many people believe; too often the critics are impressed by figures which appear large until they are seen in relation to expenditure on other aspects of consumer service and to advertising budgets in other industries.

Lord Mills has said that the investigating committee will have both full- and part-time representatives of both the gas and electricity industries, along with independent members and an independent chairman. We shall await their report with interest and some anxiety. We hope they will recognise the essential difference between functions which are competitive in character and those which are not, and that they will conclude, as others have before them, that an industry can only give a first-class service when it is kept on its mettle. If the committee wishes to make a contribution towards the creation of closer co-operation between the industries, one which will earn it the public's heartfelt thanks, let it concentrate on synchronised road excavation!

Gas from Low Grade Coal

COMPLETE gasification continues to be of very great interest to the gas industry, and is likely to remain so, since the chances of finding large deposits of high quality gas coal in the British Isles to bolster up our dwindling supplies are very remote.

To some, the complete gasification of coal in one process may seem to be a new conception, but this is by no means so. The Tully plant for gasifying non-caking coals was first developed about 50 years ago, and there was a great demand for it in the early 1920s, when the fuel shortages after the First World War were being felt. In fact, between 1918 and 1921 sales of Tully plants were very brisk. In those early days the Tully plant and other types of modified producer, such as the Mond gas plant or the Winkler plant on the Continent, were only used as sources of industrial heat or of diluent gas for rich gases, made by other processes such as horizontal retort plants, before distribution as town gas. In this way the use of coke was avoided and otherwise inferior gas making coals made use of. Since the last war the fall in coal production, the increasing price of suitable gas making coals and the greater demands for a refined fuel for both domestic and industrial consumption has again brought the need for complete gasification to the fore. Much work has been done both in this country and on the Continent to improve the existing techniques and to develop others. The Tully type of plant which makes use of the fixed bed type of producer with a retort superimposed upon it, has received a good deal of attention since the war. This type of plant depends on a cyclic operation, and means must be found for preventing the distillation products (which help so much to increase the calorific value) from being lost with the blow gases. In addition to the most modern form of Tully plant, at least two other systems have been developed in the last ten years, which appear to accomplish this satisfactorily; these systems, the Gas Integrale and the P.G.C. system, are both represented in the British gas industry.

After the inevitable teething troubles, they seem to be giving good service. Even so the calorific value of the gas made is only about 350 B.Th.U. per cu.ft. This, we feel, is going to be the real problem facing the industry. As it happens, both these plants are additions to works at which there is already carbonising plant supplying a gas which needs dilution before distribution, and the presence of this gas is most convenient for enrichment. All three systems are equipped with carburettors, so should no other means of enrichment be available, carburetted 'bituminous' water gas can be produced.

Such plant would seem to us as only a palliative by substituting a low rank coal for coke in water gas manufacture, since coke is too valuable at today's prices, and might become scarce with hoped-for future demands; and the slightly enhanced calorific value reduces the amount of oil for carburetting. Some other process is necessary to satisfy the industry's real need for reducing costs of manufacture by finding a cheaper raw material and by a saving in freight charges. The many schemes for using tail gases and the forthright and courageous plans for the import of liquified methane from the Gulf of Mexico or the Middle East are excellent, but neither of these sources is indigenous.

Some process, we think, is needed which will be capable of making a gas of suitable calorific value and suitable utilisation characteristics from a low grade fossil fuel which is to be cheap and plentiful. The increased production of small coal since the war would point to some means of gasifying this almost useless product. The complete gasification of small coals has become of such importance that a conference was held at Brussels in May, 1954, to discuss some of the problems involved and to show how solutions were being found by some of the best known contractors on the Continent. Many ingenious ideas have been experimented with in an attempt to make full use of the finely divided condition of the fuel. Fluidisation of the fuel bed and systems in which the solid fuel particles are suspended in the gasifying medium are among some of the experiments that have been tried. As yet there seem to be many difficulties to be overcome. Among these are again the low calorific value, the low proportion of gasification, the quantity of fines passing out of the reaction zone and the problem of ash extraction. It would seem that the high pressure methods of gasification could be adapted to the gas industry and that they would successfully solve most of the problems presented by the other processes.

The Lurgi system of gasification under pressure has been known for a number of years in Germany. In the past it has been used on low grade coals with success but only produced a gas of low calorific value. Within the last few years, however, development work on the Continent and research work at the Gas Council's Midland Research Station has enabled the calorific value to be raised. By modification of the path of the production gases to increase the proportion of methane, an improvement in calorific value to 440 B.Th.U. per cu.ft. has been achieved. Lurgi plants have been built in South Africa and Australia respectively. The latter is successfully gasifying a very low grade peaty lignite. The cost of these plants is high so that before the decision to build one of them can be definitely made, a cheap source of fuel must be found near which the plant will be built. A guaranteed contract price for the fuel must be settled for at least 20 years ahead, and full advantage taken of the high pressure at which the gas is made to help distribution. No freight charges for fuel raw material must be incurred.

The hydrogenation of low rank small coal is another high pressure process which might be used in this country. Experiments at the Midland Research Station

on this process were followed by similar work on the hydrogenation of oil. The latter have shown how a gas suitable as town gas can be made in large quantities. We hope that a combination of these experiments and the experience and technique learnt from the pilot plants devised for them, will help the full scale plant being built at Partington for processing oil to be quickly modified to use coal. These high pressure plants have the great advantages of making large volumes of gas from comparatively small installations and of being largely automatic in operation, but their capital cost is high. This makes continuous operation with a cheap fuel essential and, therefore the plant is not very flexible.

The need for some form of complete gasification plant is very great, but we think that if the gas industry is to be independent of imported fuel and fully competitive with the other fuel industries which can undercut it in raw material costs, some form of high pressure gasification does seem the only possible process to adopt. The fact that synthesis gases may be made by such processes is an additional argument for their use.

Nationalised Industries' Finances

IN the House of Commons last week the Chancellor was asked what provision he proposed to make for meeting the capital requirements of the nationalised industries after March 31, 1958, when the powers to make Exchequer advances expire. Replying, Mr. R. Maudling, the Paymaster-General, said that the Government proposed shortly to introduce a Bill allowing the present powers to be exercised until the end of August, but only within the limit of money already authorised. This would give time to consider the future of this method of financing these industries in the context of the Government's general policies, and to include any necessary provisions in the Finance Bill.

Pointing out that the amount that the nationalised industries will be able to borrow in the next year or two has probably been virtually decided already, as a consequence of the 'rephrasing' of public investment imposed last September, 'City Notes' in *The Times* said that the relevant question in the present context was how this total (whatever it was) would be raised. The only possible answer at the moment seemed to be that, in line with the Government's policies, that method should be adopted which made it as difficult as possible for the nationalised industries to use Treasury Bills as the source of medium-term or longer capital.

An Impartial Press

ACCORDING to the superstitious, troubles come not singly but in threes. This would certainly seem to be true of the South Western Gas Board which in the last week or two has had three 'incidents,' involving the death of five people. This type of coincidence can be very damaging to the industry's reputation and yet, in general, it is difficult to see what can be done to improve matters. What has impressed us is the fact that the statements made by the Board Chairman, Mr. C. H. Chester, and also by Mr. W. J. Baker, Board Member, in which they denied negligence and sought to show the accidents against the background of trouble-free service to 2,500,000 people in five counties, have received wide publicity. We fancy the South Western Board does not consider that it gets a particularly friendly Press in its own area; be that as it may, it would appear to us that the national Press has gone out of its way to publish both sides of the matter.

OUR PETITION

THE petition to the Chancellor of the Exchequer calling for the removal of purchase tax and hire purchase restrictions on gas-fired space heating appliances, organised by the 'Gas Journal' and 'Gas Service,' is rapidly gathering momentum. Among the bodies who have already given their support are the British Gas Staff Association, the Gas Officers' Guild, the Society of British Gas Industries, the Women's Gas Federation, Gas Consultative Councils, the Association of Supervisory Staffs, Executives and Technicians, the Standing Conference of Women's Organisations, Chambers of Trade, and a number of manufacturing firms. It is anticipated that our petition will also be backed by Members of Parliament, Local Authorities, and a variety of Trade Unions and manufacturers.

This is the first time that concerted action has been taken in this way, and we have received many letters of congratulation on our bid to bring to an end the senseless anomalies which are crippling the proper expansion of our business in the space heating field. It is worthwhile noting that some bodies who have decided not to sign the petition have nevertheless been encouraged to take action themselves. For example, the National Union of General and Municipal Workers has decided to take up the matter with the T.U.C., suggesting that this powerful 'parent' body should approach the Chancellor direct. Other organisations, while refraining from signing officially as a body, have encouraged the collection of signatures by their individual members. In this way the influence of the petition is being extended far beyond the limits of the organisations actually represented by the signatories.

Entitled 'Economics of the Madhouse,' a hard-hitting editorial on purchase tax anomalies appears in the February issue of 'Public Service,' the N.A.L.G.O. journal. Referring to our petition the editorial comments: 'While N.A.L.G.O. might not commit itself as an association to political representations of this kind, its members in the gas and electricity supply industries will certainly watch the progress of the petition with interest and sympathy—the more so since any concession gained would undoubtedly benefit both industries. Readers of "Public Service" will not need to be reminded that more than the immediate sale of appliances is involved. As we have said many times, it is only in appliances, of whatever kind, that gas and electricity are consumed at all. It is in this knowledge that gas members have been saying quite simply, "This is our bread and butter."'

May we again emphasise that this is not a mere letter or recommendation; it is a full-scale petition backed by many influential bodies and containing thousands of signatures. Very shortly we hope to be able to reveal the way in which this petition will be brought to the Chancellor's attention.

Personal Notes

MR. H. R. HART, General Manager of the Glasgow and Western Division of the Scottish Gas Board, has been appointed a Member of the Board. This is the first occasion on which an executive officer employed by the nationalised gas industry has been appointed to Board membership while still retaining the executive responsibilities of his existing apointment. Apart from a distinguished war career, Mr. Hart has spent the whole of his working life in the service of the gas industry. Before coming to Glasgow in November, 1956, when a complete reorganisation of the administrative structure of the Scottish Gas Board was just beginning to take shape, he had been for seven years Commercial Manager of the East Midlands Gas Board. The Glasgow and Western Division of the Board's area, over which Mr. Hart has charge, is responsible for the manufacture, intake and distribution of 55% of the total sales of gas throughout Scotland.

M. PAUL FINET has been appointed President of the High Authority of the European Coal and Steel Community in succession to M. RENE MAYER. M. DIRK SPIERENBURG, already a Member of the High Authority, has been appointed to the vacant Vice-Presidency, and two new Members, Dr. F. Blücher (Germany) and M. R. Reynaud (France) have also been appointed.

MR. J. I. PATON has been appointed Sales Manager by the Carron Company. He will be responsible for the co-ordination of the whole of the sales of the Company, and will assist the Manager in directing sales policy. MR. S. R. ROGERS takes over the duties previously carried out by Mr. Paton and is appointed Assistant Sales Manager (Foundries).

MR. JAMES E. DIXON, who for 35 years has been manager of Elswick gasworks, Newcastle-on-Tyne, has retired after 48 years in the gas industry. He has been succeeded by MR. GEORGE ROBSON, Deputy Manager, and former Manager of South Shields gasworks.

MR. D. D. MATHIESON has been appointed Chairman of Gas Purification and Chemical Company. He succeeds MR. J. R. SORSBIE, who has resigned from the Board owing to ill-health. MR. L. L. ROSSITER continues as deputy chairman.

MR. ROBERT STURROCK, Manager at Ardrossan Gasworks has been presented with a silver cigarette case from his colleagues in the former Western Group to mark his retirement after 40 years' service.

MR. V. P. SCHOLES has been appointed by Kelvin & Hughes (Industrial), Ltd., as Area Representative for the Midlands.

MR. KENNETH ROBINSON has been appointed Promotion Officer to the Council of Industrial Design in succession to MR. MORRIS J. BROWN. He will deal with home and overseas promotion and advertising. MISS JOYCE BLOW will continue to handle press relations. Owing to the prolonged illness of MR. TOM GREGSON, Industrial Division, MR. COLIN MACGREGOR has been appointed an Industrial Officer to handle Mr. Gregson's industries for the present and to assume responsibility for transport.

MR. HORACE R. STANLEY is retiring after 52 years in the service of the gas industry. Mr. Stanley, whose home is in Cambridge, is Sales Superintendent of the Cambridge District of the Eastern Gas Board.

MR. CHARLES ROBSON, a Director of Ashmore, Benson, Pease and Co., Ltd. of Stockton-on-Tees, has been re-elected President of the Teesside Industrial Development Board, Middlesbrough.

MR. ARTHUR GORDON COTTELL, Commercial Accountant of the Sussex Division of the South Eastern Gas Board, has retired after more than 44 years' service in the gas industry.

MR. W. D. WILSON, of George Wilson Gas Meters, Ltd., has been re-elected Vice-President of the Coventry Engineering Employers' Association.

MR. LEONARD GREEN who has recently retired at the age of 66 from the service of the gas industry at Kidderminster has been presented with a china cabinet and two chairs.

MR. HUGH H. BAIRD has resigned his Directorships of Baird & Tatlock (London) Ltd., and Hopkin & Williams Ltd., and is sailing with his family to Australia, where he intends to build plastic hulls for small marine craft.

MR. R. SOSBE has been appointed representative in Lancashire, Cheshire, and North Wales by James Gordon & Co., Ltd.

COUNTY ALDERMAN H. SUTCLIFFE has been re-appointed Chairman of the North Eastern Gas Consultative Council until May 11, 1961.

MR. F. C. REA, O.B.E., has been re-appointed Chairman of the Southern Gas Consultative Council.

Obituary

MR. BENJAMIN JOSEPH J. WELFORD, of Oxford, has died aged 82. He had been employed by the old Oxford Gas Company for 31 years, and retired some years ago as senior inspector.

MR. GEORGE F. LEEMAN, of Bishop Auckland, Co. Durham, distribution superintendent with the Bishop Auckland unit of the Northern Gas Board, has died at the age of 51.

MR. ROBERT K. FLEMING, Honorary President of Igranic Electric Co., Ltd., motor control gear manufacturers, died on February 3 at the age of 67.

CORRESPONDENCE

The Early Use of Gas in Britain

DEAR SIR,

The story of the gas industry has been so bedevilled by writers with vague claims for the 'first' this, that or the other, that I venture to replace a little true perspective to a still somewhat confused picture.

In the interesting article on 'Murdoch's Pipe,' on p. 274 of the issue of the 'GAS JOURNAL' for February 5, it is stated that the illumination of the Boulton and Watt factory in 1803 to celebrate the Peace of Amiens was 'the first record of gas lighting.'

I suggest that this is not strictly accurate. Murdoch had already demonstrated the possibilities of using gas as a substitute for oil by lighting his office at Redruth with gas distilled from coal as far back as in 1792, as your article recalls in a subsequent and contradictory paragraph. It is interesting to note that Murdoch never claimed to have 'invented' gas lighting, but he did claim 'without presuming too much, both the first idea of applying, and the first actual application of gas to economic use.'

The demonstration at the Boulton and Watts manufactory was, to use Murdoch's own words, his first 'public display' of gas lighting. But even this statement needs qualifying, for it was clearly recorded by Samuel Clegg, junior, in 1841, that although 2,600 coloured lamps were used they were illuminated by the usual small glass oil lamps. Murdoch's contribution, says Clegg, was to place at each end of the building what was known as a Bengal light (or 'flambeau'), made by conducting gas, made in a retort in the fireplace of a house below, into a copper vase. As Clegg's father was employed by Boulton and Watt, and assisted with the demonstration, there is no reason to doubt the accuracy of his account.

There is one other small point. The Treaty of Amiens was in March, 1802, not 1803.

Yours faithfully,

A. DOUGLAS LACEY.

14, Victoria Rise, Clapham Common, S.W.4.

E.G.B. Men's Team Second in First-Aid Event

CAMBRIDGE City Police 'A' won the Albert Morley shield first-aid competition, sponsored by the Eastern Gas Board, Cambridge Division, at the Central School, Cambridge, recently.

Nine male teams competed for the shield while five women's teams entered for the cup event. All teams had to deal with staged road accidents. The Eastern Gas Board men's team finished second.

This was the first occasion that first-aid teams had competed for the Morley trophies. The trophies had been presented to Mr. Albert Morley last year by the Cambridge gas division of the St. John Ambulance Brigade in recognition of his services in assisting the Gas Board's first-aid team. Mr. Morley is a retired railway official and is an Honorary Brother of the St. John Ambulance Brigade.

Presented by Chairman

The trophies were presented by the Chairman, Mr. J. Hunter-Rioch, M.B.E., who is the President of the Cambridge gas undertaking division of the St. John Ambulance Brigade.

Results:—Men: 1, Cambridge City Police 'A' (157 pts.); 2, Eastern Gas Board (152); 3, British Transport Commission Police (137); 4, Civil Defence Rescue (126); 5, British Railways 'A' (119); 6, Cambridge County Police (111); 7, City Police 'B' (105); 8, Civil Defence Ambulance (103); 9, British Railways 'B' (101).

Women: 1, St. John Ambulance Brigade 'B' (96); 2, St. John Ambulance Brigade 'A' (78); 3, Civil Defence (61); 4, British Railways 'B' (59); 5, British Railways 'A' (51).

Pictured above is a general view of the Gas Council stand at the Hotel and Catering Exhibition, Olympia, last month.

Diary of Forthcoming Events

February 14.—JUNIOR INSTITUTION OF ENGINEERS: Pepys House, 14, Rochester Row, London, S.W.1. Ordinary Meeting. Paper 'Method Study' by W. J. Kease. 7 p.m.

February 14.—INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP: General meeting and 'The Application of Servo-Mechanism Analysis to Fuel Control Problems,' by O. N. Lawrence. 6 p.m.

February 14.—I.G.E. MIDLAND SECTION: College of Technology, Gosta Green, Birmingham. Spring Meeting with paper, 'Underground Corrosion and Cathodic Protection of Piping,' by J. S. Gerrard. 2.30 p.m.

February 15. — YORKSHIRE JUNIORS: Sheffield. 'The Gas Industry and Agriculture,' by T. A. Marriott.

February 17.—SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION): Queens Hotel, Leeds: 'Modern Developments in the Provision of Raw Materials and Intermediates for the Heavy Organic Chemical Industry,' by R. Holroyd. 7 p.m.

February 18.—MIDLAND JUNIORS: Visit to works of Elwell, Ltd., Wednesbury. 2 p.m.

February 18. — I.G.E. (LONDON AND SOUTHERN SECTION): 'Trends of Civil Engineering Design in the Gas Industry,' by D. A. Andrews of the South Eastern Gas Board. 2.40 p.m.

February 18. — INSTITUTE OF FUEL (YORKSHIRE SECTION): Sheffield. 'Operational Experience at Calder Hall,' by a nominee of the U.K. Atomic Energy Authority. 7 p.m.

February 19. — INSTITUTE OF FUEL (NORTH WESTERN SECTION): Blossoms Hotel, Chester. Joint meeting with the INSTITUTION OF PETROLEUM. 'Coal and Oil as Partners in Energy Supply.' 7.30 p.m.

February 19.—INSTITUTE OF FUEL: Great George Street, London, S.W.1. Melchett Lecture for 1957, by Sir Christopher Hinton, K.B.E. 5.30 p.m.

February 19. — SCOTTISH WESTERN JUNIORS: Visit to British Luma Co-operative Electric Lamp Society, Ltd., Glasgow.

February 19.—WESTERN JUNIORS: Visit to Wilmot Breedon Ltd., Bridgewater. Students' papers.

February 19.—INSTITUTION OF CHEMICAL ENGINEERS (GRADUATES AND STUDENTS SECTION) MIDLANDS CENTRE: The University, Edgbaston, Birmingham: Annual Business Meeting and Elections followed by 'The Instrumentation of Modern Chemical Plant,' by A. H. Isaacs. 6.30 p.m.

February 20.—INSTITUTE OF FUEL (MERSEYSIDE SUB-SECTION): 9, The Temple, Dale Street, Liverpool: 'Heating, Ventilating, and Air Conditioning,' by C. G. Bell. 7 p.m.

February 21.—JUNIOR INSTITUTION OF ENGINEERS: Pepys House, 14, Rochester Row, London, S.W.1: Informal meeting with paper, 'Instrumentation in the Gas Industry,' by T. A. Lucas, S. Eastern Gas Board. 7 p.m.

February 21.—WALES G.C.C.: Bute Terrace, Cardiff. Meeting at 11 a.m.

February 22.—WALES AND MONMOUTHSHIRE JUNIORS (N. WALES SECTION): Colwyn Bay: Paper by Mr. J. Woodcock.

February 26.—COMBUSTION ENGINEERING ASSOCIATION (WELSH REGION): Park Hotel, Cardiff. 'Recent Advances in Space Heating,' by G. H. Buckle and 'Refractories for the Industrial Boiler and Furnace,' by N. W. Hinchcliffe. 10.0 a.m.

BRITAIN HAS BECOME A THREE-FUEL NATION, SAYS LORD MILLS

But Coal Remains Basis of our Economy

Minister Discusses Competition Between Gas and Electricity

THE advent of nuclear energy meant that we had reached a turning-point in our fuel and power affairs which made us a three-fuel instead of a two-fuel nation, stated Lord Mills, Minister of Power, in the House of Lords last week. But there was no doubt that coal would remain the basis of our fuel economy for many years to come.

Lord Mills said that since the end of the war the country's fuel and power supplies had been under a continuous strain. Britain had been basically a two-fuel nation, using coal and oil. While coal was the foundation of our fuel economy, the importance of oil had been growing throughout the years.

Since 1948, whereas the consumption of coal had increased by 10%, that of oil had increased by 91%. Since 1948 coke consumption had increased by 15%, gas by 27% and electricity by 99%.

There was one sphere of competitive activity which attracted a considerable volume of criticism. 'This is the competition which is quite strong in places between the electricity and gas industries. Criticisms have been made, for example, of the duplication of showrooms in the same town, one devoted to electricity and the other pressing the claims of gas.' He thought the time had arrived when this matter could usefully be looked at again.

'For this reason I have decided to set up a committee to consider ways of improving co-operation between the electricity and gas boards in the performance of their respective statutory functions and in the administration of the services provided to the public of a like kind by the two industries.'

Lord Greenhill asked whether this would include the scrutiny of the amount of money spent on what one feels is unnecessary advertising.

Lord Mills said that it would, and replying to Lord Latham he said that the committee would examine all matters concerned with the retail distribution of gas and electricity, meter-reading, and the sale of appliances, etc.

Crematorium Planned

Keighley Town Council has been recommended by its Parks and Cemeteries Committee to accept, subject to loan sanction being obtained, the tender of William Mallinson and Sons (Lockwood), Ltd., of Huddersfield, for the erection of a crematorium at Oakworth cemetery. It will be further recommended that application be made for sanction to borrow £19,294 for the work, including the laying of a 6-in. gas main to Oakworth cemetery at an estimated cost of £2,050.

France Hopes to Import Natural Gas Direct from the Sahara

A SCHEME to import 3,000 mill. cu. m. of natural gas a year—three-quarter's of the country's annual consumption—is under investigation by Gaz du France. It is envisaged that the gas, which would come from the Sahara, might be taken to Southern France by pipeline from Hassi R'mel to the main Sahara natural gas field, 400 miles south of Algiers, and under the Mediterranean to Perpignan.

In developing Sahara natural gas deposits the problem will be to find markets. Most of the deposits are at Hassi R'mel, Hassi Messaoud, 75 miles to the south east, and In Salah, in Southern Algeria. Hassi R'mel alone may produce 5,000 mill. cu. m. per annum, while by 1960 Hassi Messaoud may be producing 2,000 cu. m. annually.

Current Algerian consumption of natural gas amounts to 500 mill. cu. m. per annum, and even if a steel mill and other industrial projects were developed to use the gas, present consumption could, apparently only be doubled. Consequently, if the gas deposits are to be economically developed markets must be found in Metropolitan France and elsewhere.

100 MEN STRIKE FOR BOOTS

ABOUT 100 men employed by the Power Gas Corporation, Ltd., Stockton, on contract work at the Billingham works of Imperial Chemical Industries, Ltd., went on strike recently because, they alleged, their employers had broken an agreement that they would provide boots for all men working on the site.

A representative of the men, said that the Stockton firm had refused to admit that it had made such an agreement. He added that the agreement had not been put into writing, but he insisted that the firm had approved the men's application that they should be given a pair of boots while working on the site on account of bad conditions caused by the weather.

'GO IN FOR A DEAN'

New National Advertising Campaign

LATEST announcement of an all-out national advertising campaign comes from Dean Sales Promotion, Ltd. It will be based on the theme 'Go in for a Dean.'

Between February 16 and the end of September, 13 8-in. double column advertisements will appear in the *Daily Express*, the *Daily Mirror*, the *News Chronicle*, *Dispatch*, and the *Daily Herald*. Six quarter page advertisements will appear in the *Radio Times*, commencing February, and five half page advertisements, commencing March, will appear in *Good Housekeeping*, *Home*, *My Home*, *Wife & Home*, and *Woman & Home*.

There will be nine television magazine spots on the London network, seven in the Midlands, seven in Scotland and seven in Wales.

In the national dailies, the Company will be featuring Dinkie Dean and using other advertisements of a generic type. In the *Radio Times*, magazines, and on television, they will be featuring the Dinkie Dean, but in due course advertisements of other appliances will be used.

In addition, new displays and other advertising material, such as posters and streamers, will be available. During the Gas Council national campaign for home laundry in May, they will advertise in provincial papers.

Increase Planned

Because of higher cost, the North Eastern Gas Board is to increase basic maintenance charges to £2 19s. 6d. a year from April 1. Scarborough Council expects this to add £3,000 to their street lighting bill.

Gas Sales Rise

North Thames Gas Board estimated gas sales for December, 1957, were 40,269,000 therms, compared with 35,590,000 therms for the corresponding period in 1956.

NEW LOADS FOR THE AMERICAN GAS INDUSTRY

Air Conditioning a 'Must,' says Utility Chief

from HILDING CARLSON

IT'S going to get worse! '

With that view of future electric competition for the gas undertakings, delegates to the annual American Gas Association convention were given first-hand information about the recent purchase of the Servel air conditioning division, the plan for its development, and the assertion that gas air conditioning is 'an absolute necessity for the industry'

'I don't need to tell you that the gas industry already is facing a severe competitive situation,' Mr. J. C. Hamilton commented in an address that presented a programme with high economic potential for the industry, during a convention that was otherwise indistinguishable from its predecessors as to agenda and content.

Significant Difference

While much of Mr. Hamilton's programme has been offered to the American industry during the past five years, the significant difference is that he addressed the convened executives from gas undertakings throughout the nation as one of their number. His convictions on the necessity for a gas air conditioner, and the practicability of selling it, were substantiated by a selling history and selling enthusiasm in the service area of his undertaking.

Reasons are complex for the failures to adopt previous presentations of gas air conditioners to the American industry. Certainly, one reason is the self-same 'complacency' to which Sir Harold Smith, Chairman of the Gas Council, referred in his address to the Scottish Association of Gas Managers in St. Andrews during late-September.

The American industry has been implored, cajoled, beseeched, and threatened for its complacency. Some undertakings have not been in that state, others have come out of it. But, there are too many that have not emerged to face and fight the 'severe competition situation.' The effectiveness of Mr. Hamilton's presentation will be judged only by the adoptions of it and the sales records. Lip-service to well-calculated programmes designed for a more vigorous total American industry, unfortunately, are too great a part of its recent history to warrant a forecast in this instance.

Electric undertakings are cutting into the cooking and water heating loads; the electric heat pump is being promoted and sold now for all-year air conditioning.

'We can expect them to use every resource within their reach to secure acceptance in order to balance summer air conditioning with winter heating,' Mr. Hamilton predicted. That danger to gas loads has been seen for several years. It is the counterpoint to the gas industry's characteristic annual curve for gas sendout, with high peaks in winter and deep valleys in summer.

'We have realised that gas air conditioning was the remedy but the lack of an effective and efficient gas air conditioning appliance has, until recently, handicapped us severely,' Mr. Hamilton recalled.

Mr. Hamilton is President of Arkansas Louisiana Gas Co., an undertaking with approximately 225,000 customers in the states of Louisiana and Arkansas. Also, Mr. Hamilton is President of the newly-formed Arkla Air Conditioning Corporation, which purchased the Servel division.

Experiences with developmental gas air conditioning units produced by five companies were 'discouraging, to express it mildly,' Mr. Hamilton stated in his recital of experiences in his service area.

The undertaking was encouraged to continue its promotional and selling efforts. The installation of 320 Servel units in a single residential development, during 1954, provided an impetus and the opportunity for observation of operational and economic characteristics.

Summer temperatures in this southern service area are apt to stabilise close to 100°F. for protracted periods. Satisfactory performance in the South is an essential requirement to the success of any air conditioner.

Far from Perfect

The 320 houses, Mr. Hamilton explained, were of medium size and have adequate thermal insulation for the air conditioning installations. Most of the houses are equipped with units having two tons of refrigerating capacity.

American engineers define a ton of capacity as providing heat removal for comfort cooling at 12,000 B.Th.U. per hour, equivalent to heat required to melt one ton of ice in 24 hours.

The 1954 installations 'were far from perfect,' Mr. Hamilton told the A.G.A. convention. A year of work was required to put them into condition for satisfactory service. Now they operate efficiently and dependably.

Revenues from the 320 customers have come up to expectations, he said, in a 1954-55 summary based upon the Arkansas Louisiana gas tariffs—two-ton installations, annual average—188,000 cu.ft. per house; overall average for immediate area—110,000 cu.ft. per house; two-ton installations, gross revenue—£31 8s. 7d.; overall average for immediate area—£20.

The 188,000 cu.ft. annual average for the 320 homes was analysed—cooking and water heating, 36,000 cu.ft. per year; space heating, 81,000 cu.ft.; summer cooling, 71,000 cu.ft. The gas used for cooling accounted for an average revenue of £10 7s. 2d.

These installations are largely a departure in the heating practice of the area. Average residential customers utilise individual room heaters that are similar in appearance and performance to those used widely in Great Britain. With the installations of central year-round equipment by the Arkansas Louisiana undertaking, the gas volume sold for heating in the 320 homes expanded beyond the local average.

'Gas company sponsorship and guarantee of adequate service and maintenance are two of the deciding factors in a successful programme to sell air conditioning,' Mr. Hamilton observed. 'Our sales experience in recent months has convinced me that the gas companies themselves must take on the prime responsibility of connecting the air conditioning load if an adequate job is to be accomplished. The companies have the greatest incentive . . . and they can install and maintain the units at the lowest cost to the customer.'

The new company has projected an intensive research and development programme to improve the present product and to add other equipment as customer requirements develop.

Approximately 50 gas undertakings have agreed to purchase a minimum of 4,600 units during the year to end in October, 1958. A special price of £462 was arranged for those purchases of 3½-ton units and about £604 for a new five-ton unit.

The estimates for the eventual production rate, Mr. Hamilton noted, vary from 10,000 to 12,000 units per year, 'to justify the large expenditures necessary to the success of the new company.' Large amounts must be put into national advertising, promotion, product research and development programmes, he said.

Complacent Comments

The American gas executives were referred to the complacent comments that have been quite general, 'You can't sell gas air conditioning,' or 'The price is too high,' or 'People are not ready for air conditioning and central heating in this area.'

'We have proven,' Mr. Hamilton said, 'that such pessimistic remarks are nothing but excuses to cover failure to use the required effort.'

The successes of individuals in the Arkansas Louisiana undertaking were detailed to substantiate his contention that gas air conditioning can be sold. The local manager in an area with a population of 3,500, he emphasised, had sold 27 all-year air conditioners and then

' installed them himself.' Homes, banks, and restaurants are on his list of installations.

' Nobody told him he couldn't sell gas air conditioning, nobody trained him,' Mr. Hamilton said. ' He just went out and sold them.'

Turning to the diagrams, Fig. 1, is the flow diagram of the Arkla-Servel all-year gas air conditioner, shown here in cooling cycle. The system is charged with lithium bromide and water. Water is refrigerant in this cycle, lithium bromide solution the absorbent. The entire system operates under vacuum at all times.

Water is boiled off in generator, the gas burner is directly beneath it. As vapour is driven off, the absorbent solution is vapour-lifted to the separator.

Separated by Baffles

Refrigerant vapour and absorbent solution are separated by baffles. The vapour rises to the condenser, and the solution falls through heat exchanger to absorber.

As the refrigerant vapour passes from the separator to the condenser, it returns to the liquid phase due to action of the cooling water in the condenser tubes. The cooling water is from an external source.

Refrigerant water leaves condenser through a tube containing a restriction. That creates a pressure barrier to separate the slightly higher absolute pressure in condenser from lower pressure in cooling coil. The water vaporises as it enters the lower pressure in the cooling coil. That pressure—or high vacuum—lowers the boiling temperature sufficiently to produce refrigeration.

Air to be cooled for personal comfort flows over finned horizontal tubes of the cooling coil surface. As evaporation of the refrigerant occurs in the coil, the heat of evaporation for the refrigerant is extracted from the external air stream to accomplish the cooling and dehumidification of that air for personal comfort. Refrigerant vapours are absorbed adjacent to the cooling coil.

While the refrigerant vapour flows from the separator, the absorbent lithium bromide falls to the liquid heat exchanger and passes to the absorber.

Cooling water from an external source circulates through the coil within the cylindrical absorber. Absorbent from the heat exchanger is distributed from the top of the absorber over the cold water coil to get maximum exposure to refrigerant vapour in its movement from the cooling coil.

Rate Increases

The strong affinity for water vapour of lithium bromide accounts for the reabsorption of refrigerant vapour by the solution. Rate of absorption increases at lower temperatures, therefore requiring the cold water coil within the absorber.

Then, refrigerant water and lithium bromide solution flow back through the heat exchanger to the generator, where the refrigerating cycle repeats as boiling action separates the components.

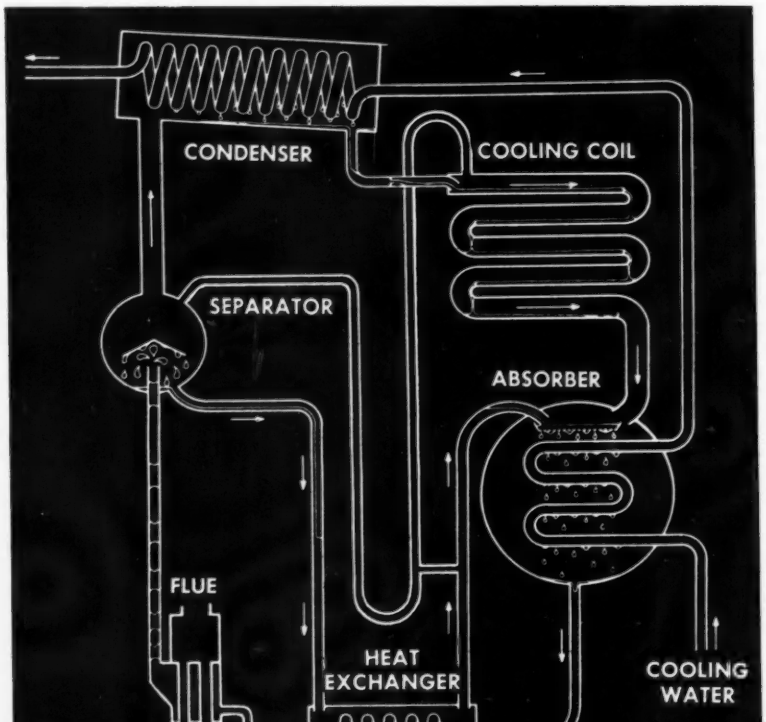


Fig. 1.

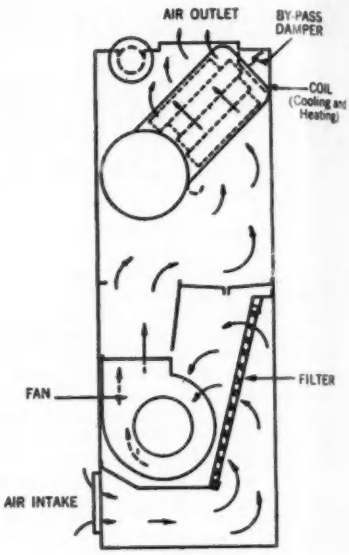


Fig. 2.

The heating cycle is started by closing a valve in the external cold water supply to the absorber.

The lithium bromide and water solution, as in the cooling cycle, boils in the generator, water vapour and lithium bromide are driven to the separator for the effect of the baffles.

Pressure Increase

Now, with no cold water in the absorber coil, the water vapour in the system causes an increase in pressure as it rises to the condenser. Only a small volume of vapour can pass the restriction between the condenser and the cooling coil—which functions now as the heating coil.

Increased pressure permits the water vapour to pass through a trap into a second separating chamber (not shown in flow diagram, for simplification), from which it flows to the heating coil where it condenses and transfers heat through the finned horizontal coil to the comfort-air system.

Condensed water then flows back to the second separating chamber where it mixes with lithium bromide solution and flows on to the generator for repetition of the cycle.

During the heating cycle, there is no flow of lithium bromide to the absorber, since the pressure difference is not sufficient to force the liquid upward from the heat exchanger to the top of the absorber.

The second separating chamber, functioning primarily during the heating cycle, serves also as a concentration control chamber during the cooling cycle. Then, it maintains a relatively constant supply of strong lithium bromide solution for a working range of inlet temperature in the externally supplied cold water.

The outward appearance of the Arkla-Servel unit is similar to conventional

modern central heating units. The insulated jacket is 27 in. wide, 55½ in. long, 74 in. high.

Fig. 2 gives a diagrammatic representation of the air-flow, while seasonal changes in consumer demands for gas and electricity in America are represented in Fig. 3. Here the imbalance in load for the gas undertakings, caused largely by the continuing expansion in their house heating business, is clearly demonstrated. The character of the gas curve indicates the economic reason for urgent attention to the development of gas air conditioning business. Gas undertakings can take on the load without one penny paid out as capital expenditure.

The sharpness of the peak in electric demand has been brought on by the heavy sale of room-unit air conditioners for residences and offices. The summer load created by those units is added without prior notice to the electric undertakings and with consequent strains on their distribution systems.

Also, individually-heavy additions to the electric load come from air conditioning equipment installed in larger buildings. There is an opportunity for advance planning in those instances.

Gas air conditioning, it can be assumed, would reshape the gas curve with an upswing to start in mid-June and a return to the present curve at the end of August.

The height of the upswing has immediate importance to the American gas industry. However, the wiser long range view must consider the effects on the gas peak that will follow the electric industry's efforts to balance its high peak with a heating load, dependent upon Lord Kelvin's heat pump.

The industry has before it for early decision the kind of regard and action with which it will meet this threat. The decision involves many of that industry's tomorrows.

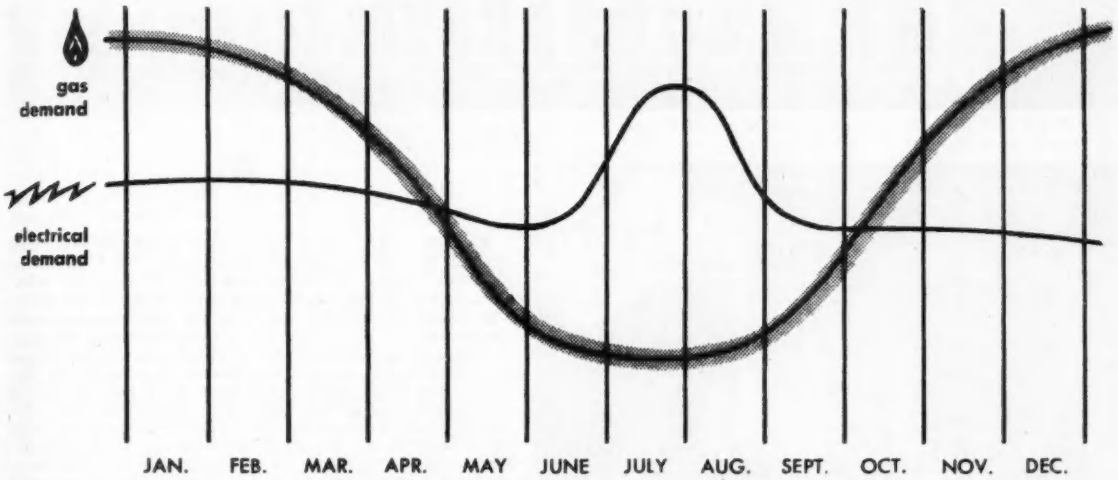


Fig. 3.

GORDON RESEARCH CONFERENCES

THE Gordon Research Conferences for 1958 will be held from June 9 to August 29 at Colby Junior College, New London, New Hampshire; New Hampton School, New Hampton, New Hampshire; and Kimball Union Academy, Meriden, New Hampshire.

The Conferences were established to stimulate research in universities, research foundations and industrial laboratories. It is hoped that each Conference will extend the frontiers of science by fostering a free and informal exchange of ideas between persons actively interested in the subjects under discussion.

Requests for attendance at the conferences, or for any additional information, should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, Rhode Island.

In the section devoted to coal, June 23-27, Dr. F. J. Dent, Director of the Birmingham Research Station of the Gas Council, will speak on 'The Hydrogenation of Coal for Gaseous Hydrocarbons,' and 'Experiments on the Gasification of Coal in Fixed-Bed Pressure Gasifiers.'

ELECTRONIC BRAIN PLANS GAS MAKE

INTRICATE mathematical calculations which have been completed at Wolverhampton will make it possible to forecast with reasonable accuracy an average temperature in Birmingham and the West Midlands for every day in the year. These forecasts are to be used by the West Midlands Gas Board to regulate day-to-day output of gas.

Calculations based on daily temperatures recorded in the area over the last 50 years have been going on since the autumn, on the computer installed at the Wolverhampton and Staffordshire College of Technology. The project was undertaken for the Gas Board by Mr. Roy Woolridge, senior lecturer in Mathematics in charge of the electronic computer at the College.

New Sc.G.B. Showroom

The Scottish Gas Board is to convert a house and shop in Burntisland (Fife) High Street, into a showroom, store, and office.

BLAST FURNACE GAS OUSTS OIL IN NEW FACTORY

A PIPELINE 2¼ miles long to supply the new factory of British Cellophane, Ltd., at Barrow-in-Furness, with gas from the blast furnaces of the Barrow ironworks is expected to be completed by September.

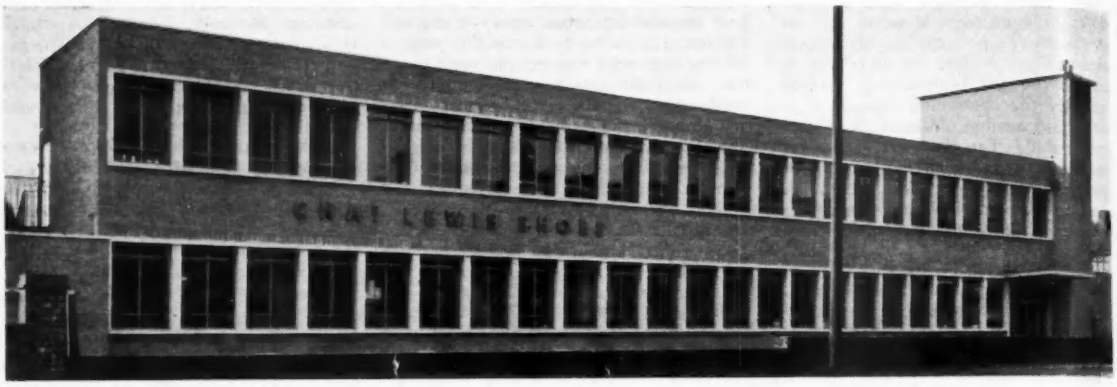
It is understood that terms have been agreed between Barrow Iron Works, Ltd., and British Cellophane, Ltd., by which the latter will take an increasing amount of gas over a number of years, with the maximum demand likely to be the total surplus output of the ironworks.

Preparation of the foundations has already been begun, and the blast furnace gas will replace oil for the firing of the boilers to be installed in the new factory.

Merger Approved

Shareholders of Yorkshire Copper Works, Ltd., of Leeds and Barrhead, have formally approved the plan for a merger with the Metals Division of Imperial Chemical Industries, Ltd. The company formed to effect the merger is named Yorkshire Imperial Metals Ltd., and the present company's name is to be changed to Yorkshire Copper Works (Holdings) Ltd.

GAS IN A MODERN SHOE FACTORY



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Pictured above is the front elevation of the first factory erected for the Leyton Borough Council at Church Road industrial estate. It has been taken by Chas. Lewis (Shoes) Ltd., and following negotiations between the North Thames Gas Board industrial section and the architect, gas heating was installed. Altogether 31 overhead radiant heaters are arranged in four banks to give a uniform distribution of heat. A general view of this installation is seen below right. Each bank is separately controlled by a Perl 60 magnetic relay valve actuated by an electric room thermostat. Total output of these heaters is 558,000 B.Th.U. per hour. Combined with them, a system of controlled ventilation is maintained by passing all incoming air through the gas fired air heater seen left centre. The output of this heater is 140,000 B.Th.U. per hour. An exhaust fan operates at the opposite end of the factory. In addition, two hot water storage appliances, each of 45,000 B.Th.U. output, have been installed, one of which is seen below left, as well as gas cookers and incinerators.

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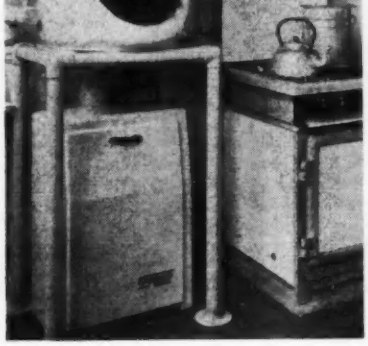

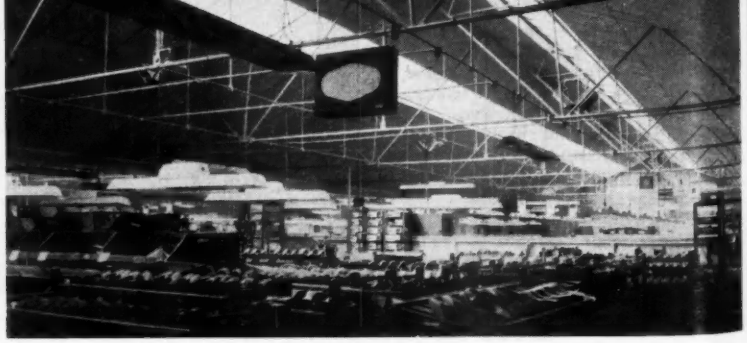

Accidents Caused by Defective Gratings and other Pavement Structures

By T. J. SOPHIAN

AN important judgment has recently been given by the Court of Appeal on the question of liability for accidents suffered by pedestrians as the result of defective structures on pavements such as gratings, lights, cellar flaps, and the like. Macfarlane *v.* G. Walker (1958) 1 A.E.R. 181.

In such cases can the occupier of the adjoining premises, to which the structure belongs, be made liable? Or on the other hand is the responsibility to be thrown on to the local authority in whom the pavements happen to be vested?

Where a street, which will usually include the pavements as well, is dedicated to the public, it will be taken over by the local authority in the condition in which it is. If any part is in disrepair, or if it should subsequently fall into disrepair, the local authority cannot be made liable for any accident that may result in consequence.

As long ago as 1788, in the case of Russell *v.* Men of Devon, it was held that the inhabitants of a county in whom a bridge was vested, could not be made liable for injury caused to an individual in consequence of the bridge being out of repair. It is from this decision that the present day principle is derived, that a local authority in whom, as successors of the inhabitants, highways are now vested, cannot, equally, be made liable for injuries or damage caused by disrepair of the highway.

Neglect to repair is termed 'non-feasance' or failure to act, and it stands on an entirely different footing from what is termed 'misfeasance,' or acting in a wrongful manner. For misfeasance, a local authority will clearly be liable, but not for 'nonfeasance.' The reason for this distinction is that the earlier statutes of the 19th century which placed the liability to repair on surveyors and local authorities were intended merely to provide the means for securing the execution of the necessary work of repair to highways; they were not designed to create any new right of action as against local authorities.

Pavement Level Raised

As an instance of a misfeasance for which a local authority was accordingly held liable one may note the case of Penney *v.* Berry (1955) 3 A.E.R. 182. There the defendant was the owner of premises adjoining the highway. There was an opening to his cellar in the surface of the pavement, which also was part of the highway. This opening was covered by a metal slab set in a large flagstone. In 1950 the local authority had raised the level of the pavement and in reconstructing it had placed a concrete surround round the metal slab, which was then made to rest on a concrete ledge. One side of the slab was about ¾ in. higher than the pavement instead of being flush with it, and it constituted a public nuisance. The plaintiff tripped over the projecting slab and injured himself, and he sued the owner of the adjoining premises.

The Court of Appeal stated in their judgment that the local authority would have been liable to the plaintiff for the 'misfeasance' in resetting the metal slab in this way and not flush with the pavement, had proceedings been brought against them within the time limits set by the Limitation Acts. The Court also held that the adjoining owner, the defendant, was not liable. It was sought to make the adjoining owner liable under the provisions of s.35(1) of the Public Health Act Amendment Acts, 1980.

Under this provision, all vaults, arches, and cellars under any street, and all openings into such vaults, arches or cellars in the surface of any street, and all cellar heads gratings, lights and coal holes in the surface of any street, and all landings, flags or stones of the part or street supporting the same respectively shall be kept in good condition and repair by the owner or occupiers of the same, or of the houses or buildings to which the same respectively belong.

This provision, it will be observed, therefore, refers to all these various types of structures one finds in streets and pavements such as cellar flaps, gratings, coal plates, pavement lights, and other structures, whether they are in the surface, or under the street or pavement. The intention of this provision is to cast on the owners or occupiers of these structures, or on the owners or occupiers of the adjoining buildings, for whose use and benefit they are, the duty of keeping them in repair.

The provision speaks of the structure 'belonging' to a house or building which means that the structures came into existence and continued to exist for the sole benefit of the particular house or building, as, for instance, by providing a means of access to its coal bunkers or cellars, or by providing light through pavement lights to underground rooms, and the like.

No Liability

The duty that is imposed by s.35 of the 1890 Act on the owner or occupier however is one which relates to repair and condition. And if the structure itself and its surrounds are in good repair and condition, no liability can attach to the adjoining owner or occupier.

Thus in Penney *v.* Berry, the cover itself and the surround and flagstones were all in good repair and condition; what was wrong, was the design or lay-out in which they were set, when the pavement was reconstructed. That did not constitute a lack of repair and condition. Accordingly the adjoining owner was held not to be responsible.

With this case, however, the recent grating case of Macfarlane *v.* Gwalter is in strong contrast.

There, a grating in the pavement which admitted light to the cellar window of an adjoining building was in bad condition and constituted a danger to passers-by. The plaintiff, an infant, stepped on to the grating and his foot went through it and he was injured.

The Court of Appeal held that the occupier of the adjoining building, who knew of its condition, was liable under the above provisions of s.35(1) of the 1890 Act. That provision cast on him a duty to repair the grating, which he had neglected.

The difference between this case and Penney *v.* Berry rests on the fact that whereas in the former, there was neglect to repair the structure, in the latter there was no such neglect, the structure itself being in good repair and condition.

The case of Macfarlane *v.* Gwalter is of further interest in that it raises an important point, as to whether any duty was cast on adjoining owners or occupiers in cases, where the structure of which complaint was made, was part of the highway itself, which had been dedicated to and taken over by the local authority. The Court of Appeal held that the liability of the adjoining owner or occupier for non-repair of the structure was not affected in any way by the question whether or not the structure also was so dedicated to and taken over. In that case the evidence was clear that the structure was already on the pavement, when the pavement and highway were taken over by the authority, but the Court of Appeal held that this fact did not in any way affect the question of liability of the defendant, as occupier of the adjoining premises, to which the grating belonged.

British Standard for Roofing Amended

TO remove ambiguity from the recently published British Standard for Mastic Asphalt for Roofing (B.S. 1162:1957), a simple amendment to Clause 4 has been issued, the purpose of which is to confine the selection of natural rock asphalt, when used in blends in the manufacture of mastic asphalt for roofing, to those rocks having an inherent bitumen content of 6 to 10%.

From a paper to the Manchester and District Junior Association of Gas Engineers, December 12, 1957.

Wear Resisting Materials

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THIS paper is a short account of some experiments which have been carried out at various works in the North Cheshire Group to find alternative materials to mild steel for apparatus handling coal, coke and ashes. The two most tried for general use were stainless steel and aluminium, while several materials have been tried in conveyor chutes. The first part of this paper will deal with the use of stainless steel and aluminium. Chutes will be discussed in the second part.

Material Specifications.

Mild steel. Ordinary mild steel plate $\frac{3}{16}$ in. or $\frac{1}{4}$ in. thick.

Stainless steel. The material used contained 0.6% carbon, 18% chromium and 8% nickel. It was supplied in sheets 12's gauge thick, cold flattened and unpolished, and was described as a weld decay proof austenitic steel.

Aluminium. The aluminium used was $\frac{1}{4}$ in. thick sheets. It was an alloy containing 1% silicon and 0.75% magnesium. Its official name is Noral B.51 S.W.P.

A comparison of costs between these materials is shown in Table I.

TABLE 1

Material	Cost per sq. ft. Shillings	Cost Ratio	
		to $\frac{3}{16}$ in. MS	to $\frac{1}{4}$ in. MS
$\frac{3}{16}$ in. Mild steel ..	3·42	—	0·75
$\frac{1}{4}$ in. Mild steel ..	4·55	1·33	—
Stainless steel, 12 gauge	21·0	6·1	4·6
$\frac{1}{4}$ in. Aluminium ..	11·0	3·22	2·4

These costs will be used in the cases which follow where figures are available to calculate the actual costs of using the materials.

Before considering individual uses of stainless steel and aluminium the difficulties over welding them should be looked at. The difficulty arises in 18/8 stainless steel because of its high co-efficient of expansion (50% greater than mild steel), and its conductivity of heat and electricity. Aluminium presents difficulties due to its high heat conductivity and its non-change of colour with rise in temperature. Because of these points, it is generally recommended that direct current should be used for welding as it gives a steady arc, whereas alternating current does not.

As there was no direct current welding machine available, it was decided to purchase an arc stabiliser unit which could be operated in conjunction with existing welding transformers. This apparatus consists of a high frequency generating unit of the spark gap type, coupled so as to superimpose the high voltage current on the welding circuit to assist in starting and in stabilising the arc. It has enabled satisfactory welds to be made with aluminium and has improved the quality of welds with stainless steel.

At one works, coke is removed from the retort house by electrically driven trucks which carry skips holding 7-8 cwts. of coke. These skips had been made from $\frac{3}{16}$ in. thick mild steel sheet. It was not possible to use thicker sheet because of the limit of weight. Skips made from 12's gauge stainless steel, suitably reinforced with strips of stainless steel welded edgeways to the outside of the skip, were fitted to the trucks. These skips have been in use for 18 months and are considered good for another 12 months' service. The mild steel skips only had a life of six months. Assuming that manpower and material costs remain constant, it is possible to calculate the saving by using stainless steel. A stainless steel skip with five times the life of one of mild steel costs £75, which compares favourably with mild steel at £35, or a total cost of £175 over $2\frac{1}{2}$ years. Over this period, there will, therefore, be a saving of £100 or £40 per truck per year.

At another works, the coke from the retort bench is discharged into barrows which are pushed by hand. These barrows have in the past been made from $\frac{3}{16}$ in. thick mild steel, and the complete barrow weighed $5\frac{1}{2}$ cwts. After frequent complaints from the stokers about the weight, it was decided to make a barrow body from aluminium. The aluminium barrow weighed only $3\frac{1}{4}$ cwt., a saving in weight of 40%. While it is difficult to compare the wear which has taken place during the six months the barrow has been in use with the wear on mild steel barrows, the indications are that it will last at least twice as long as a mild steel barrow. The relative cost of an aluminium body was £63, compared with £38 for mild steel. If the longer life is realised, money will have been saved and the original object of reduced weight will also have been achieved. During the construction of the aluminium barrow, however, care was taken to separate the aluminium body from the mild steel frame by the use of polythene sheets and washers, to avoid the possibility of constructing a cell, and the aluminium being eaten away by galvanic action.

At one works in the Group, a barrow for wheeling ashes from the producers was made from 12's gauge stainless steel, some 10 to 12 years ago (the exact date was not recorded) and it has been in continuous use ever since. It is estimated to have at least another ten years' life.

At a works handling approximately 1,200 tons of coal a week by a gravity bucket conveyor, six cast aluminium buckets have been fitted. The life of a mild steel bucket on this conveyor is 18 months to two years. The aluminium buckets have now been in use for 15 months and show no appreciable wear. The life of these buckets has been variously estimated from 5 to 10 years. Therefore, at the lowest estimated life, the cost of these buckets would be just recovered, since they are $2\frac{1}{2}$ times the cost of the mild steel ones. A marked advantage of the aluminium buckets is that they do not become clogged with coal dust, particularly during wet weather. It is necessary to clean out the mild steel buckets as they accumulate fine coal in the bottom which reduces the capacity of the conveyor. So far this has not been necessary with the aluminium buckets.

Rapid Wear

Both stainless steel and aluminium have been tried for dead plates on coke screens at different works. At one works a composite plate was made from 12's gauge stainless steel and $\frac{1}{4}$ in. aluminium. The aluminium wore away fairly quickly, not as quickly as mild steel, but quicker than stainless steel. During the period the aluminium wore away, the stainless steel lost no measurable thickness. This part of the investigation is not complete, but it would appear that stainless steel will last about six times as long as mild steel. One shortcoming of stainless steel is that for spans over 2 ft., it is necessary to reinforce the plate with strips of stainless steel welded edgewise to the base of the sheet or to use the plate as a liner for mild steel. There is evidence that if the stainless steel is subject to flexing, the wear is quite rapid. Under these circumstances the wear starts as a series of pin holes which grow rapidly.

It would seem that one of the reasons for stainless steel lasting longer than mild steel is that the wet coke leaves the mild steel in a condition which is readily oxidised. The result of this is that a small amount of the steel is corroded away after each pause in operations. Apparently this oxidation does not take place with stainless steel, but does so to a smaller

extent with aluminium. If this is the case, then the wearing of stainless steel is purely abrasive wear. This explains its long life, since it is a hard metal which work hardens. Stainless steel, however, does not give a much better service than mild steel where the coke drops on to it.

At Denton works, mechanical producers are installed which are designed to gasify coke from 0 in. to ¾ in. in size with not more than 15% below ½ in. Originally the run of retort house coke was passed over ½ in. by ¾ in. slots of mild steel weld mesh, but this did not give the required quality fuel. These screens blinded within minutes, and if left, built up to form a hump.

Mild steel wedgewire screens, set at $\frac{3}{16}$ in. apertures, were a distinct improvement on the weld mesh screens, but these too became blinded eventually. It was then decided to try wedgewire mats made from stainless steel. These have been most encouraging. After initial teething troubles, a mat has lasted ten months as against six to eight weeks for a mild steel wedgewire mat, nor has it once been necessary to clean a stainless steel mat during the whole of the time they were in use. Presumably this freedom from clogging is due to there being no corrosion of the stainless steel. These stainless steel mats cost approximately £25, which is three times the cost of mild steel wedgewire, but they are clearly well worth the extra cost since they last approximately six times as long with better performance. In the course of a year the cost for stainless steel would be £30 and manpower costs for fitting two mats, but for mild steel, it would be £50 to £60 and manpower costs for fitting six to eight mats.

Other wear resisting materials have been tried for the lining of coal and coke chutes. These materials include Staffordshire blue splits, lesco tiles (hardened fireclay tiles), glass, stainless steel, cast basalt, cast iron and mehanite. They have different properties, some being suitable under certain conditions, where others are not.

At Denton, where 900 tons of coal and 400 tons of coke are handled daily, the chutes, generally, are lined with blue splits when handling coal, and cast basalt for coke or coke and coal.

On chutes lined with blue splits and handling wet coal, the flow was impeded by a build up of coal breeze. These conveyors were designed to handle 120 tons of coal per hour, but under these conditions the capacity was reduced to about 40 tons per hour. To try and cure this, glass was tried on a chute with a shallow feed. No build up whatsoever was experienced, and the capacity went up to as much as 150 tons per hour. Normally this chute only handles coal. The twin belt of the one just mentioned handles both coal and coke, and the chute was lined with lesco tiles. These tiles have proved very satisfactory, since a glazed surface is formed which does not impede the flow in any way. They have been in use for nine months and only two tiles, at the point of impact, have been replaced. These tiles wear much quicker if coke or coal is allowed to hit the edge of them, than if it runs smoothly over the surface. The glass lining has handled about 120,000 tons of coal and shows no sign of wear. The lesco tiles have handled about 40,000 tons of coke and 20,000 tons of coal. Glass is naturally unsuited to coke under any conditions because of the coke's abrasiveness.

Stainless steel of 12's gauge has a life of only hours with coke. Cast iron and mehanite both last longer than blue splits, the length of life being dependant on thickness. Half of the wear appears to be due to abrasion and half to corrosion caused by rust. Cast basalt wears slightly quicker than cast iron and mehanite, but longer than blue splits and lesco tiles. These tiles are better at the point where the coke makes contact than are blue splits and lesco tiles.

Where any extra expense is incurred by fitting more costly materials, the saving in manpower costs and time and the avoiding of costly maintenance of work by the better wearing quality of the material must always be borne in mind.

From a paper to the Manchester and District Junior Gas Association, December 12, 1957.

Calculating Producer Coke Consumption from Producer and Waste Gas Analyses

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A METHOD of calculating the amount of coke used in a producer, based on a knowledge of the composition of the producer gas and waste gas, which also serves as a check on the tightness of the retorts, is described.

A complete analysis of the producer gas and waste gases of a retort setting was carried out by means of either an Orsat or Godderham gas analysis apparatus. The proportion of water in both gases was found by passing a known volume of gas through U tubes containing a drying agent. The gas from the main was passed through three U tubes, the first two of which contained a mixture of granular and powdered silica gel and the third phosphorus pentoxide. If phosphorus pentoxide was used exclusively, the reaction was found to be so vigorous that heating and eventually cracking of the U tubes occurred. In the early experiments, the gas was drawn from the main, through a silica rod, by means of a small electric pump, but this was not successful since there was no adequate control over the flow of gas. It also involved the use of a meter which was not desirable since, wherever a further piece of apparatus, was introduced, condensation took place or an alteration in volume occurred due to the dry gas taking up water. Eventually, a pair of calibrated aspirator bottles were used, and these were found to give adequate control over the flow of gas and made the use of a meter unnecessary. Difficulty was experienced in stopping the water condensing before it reached the U tubes. This was overcome by placing the U tubes as near to the main as possible and by inserting a spiral of copper wire down the silica tube so that heat from the main was conducted to the cooler parts of the tube.

The three U tubes were each weighed separately and a known volume of gas was passed through, and the increase in weight measured. The water content of hot waste gas was found as follows.

The total increase in weight was found to be .740 g. and the volume of gas passed was 9.2 litres. Since 18 g. of water vapour occupy 22.4 litres, .740 g. occupy $\frac{22.4 \times .740}{18}$ or .9206 litres. The percentage of water, therefore, in the gas is $\frac{.9206 \times 100}{9.2}$ equal to 10%. Similarly, the water content of the producer gas can be found, and provided that combustion is complete, the percentage of water vapour in the waste gases can be calculated from the equation;

$$\frac{\%\ (CO_2+CO) \text{ in producer gas}}{\%\ (CO) \text{ in waste gas}} = \frac{\%\ (H_2O+H_2) \text{ in producer gas}}{\%\ (H_2O) \text{ in waste gas}}$$

This also affords a means of testing whether any leakage occurs in the retorts.

In order to calculate the amount of coke used on the producers all the gas from the producers under test must pass through one waste heat boiler. This boiler is used as a calorimeter, and the amount of steam raised for a known amount of gas is found. The boiler must be fitted with means of measuring the inlet and outlet gas temperatures, the inlet water temperature, the degree of superheat, the steam pressure and the amount of steam raised per hour.

An analysis of the producer gas was made, and it was assumed that the Orsat sample contained 2% water by volume at the ambient temperature. Since experimentally the water content of the hot producer gas was found to be 6%, this analysis was corrected to a 6% water basis, *i.e.*, 4% above the 2% in the Orsat sample. Both analyses are shown in Table 1.

TABLE 1

Constituent	Actual analysis of producer gas (%)	Analysis corrected to 6% water (%)
H_2O	2·0	6·0
CO_2	6·0	5·75
CO	28·0	26·90
H_2	11·0	10·56
CH_4	·8	0·77
N_2	52·2	50·02

From the corrected analyses shown in Table 1, the theoretical waste gas analysis is calculated, assuming perfect combustion.

	Products of Combustion %		
	H_2O	CO_2	N_2
See Table 1	6·0	5·75	50·02
$2CO+O_2+HN_2 \rightarrow 2CO_2+4N_2$		26·90	58·80
$2H_2+O_2+4N_2 \rightarrow 2H_2O+4N_2$	10·56	—	21·12
$CH_4+2O_2+8N_2 \rightarrow CO_2+2H_2O+8N_2$ ..	1·54	0·77	6·16
	18·10	33·42	131·10
Total of all products		182·62	

The theoretical waste gas analysis will, therefore, be:—

$$H_2O \quad \frac{18{\cdot}10 \times 100}{182{\cdot}62} \quad \% \; 9{\cdot}92$$

$$CO_2 \quad \frac{33{\cdot}42 \times 100}{182{\cdot}62} \quad 18{\cdot}32 \quad (1)$$

$$N_2 \quad \frac{131{\cdot}10 \times 100}{182{\cdot}62} \quad 71{\cdot}76$$

The analysis of an actual sample of waste gas was made, which showed a 15% excess of air, so a dry air free analysis was calculated. Both are shown in Table 2.

TABLE 2

Constituent	Actual Analysis of waste gas (%)	Analysis corrected to dry, air-free basis (%)
H_2O	2·0	—
O_2	3·0	—
CO_2	16·8	20·27
N_2	78·2	79·93

If this dry air-free analysis is calculated to a 9.92% water content in the theoretical waste gases, we have the following:—

$$H_2O \qquad = \% \; 9{\cdot}92$$

$$CO_2 = 20{\cdot}27 \times \frac{90{\cdot}08}{100} = 18{\cdot}27 \quad (2)$$

$$N_2 \qquad = 71{\cdot}81$$

It will be seen that (1) and (2) are in close agreement. This shows that there is no appreciable coal gas leakage in the retorts.

Analysis (2) is now corrected to allow for 15% excess air:—

H_2O 9·92% Add 15% air H_2O 9·92 × ·85 = 8·43%
CO_2 18·27% CO_2 18·27 × ·85 = 15·52%
N_2 71·81% O_2 = 3·00%
N_2 = 73·05%

The specific heat of this waste gas in B.Th.U. per lb. is then calculated. If the molecular weight of gas in ounces occupies 22.4 cu.ft., then the weights of the flue gas constituents can be calculated. From the individual specific heats, the specific heat of the flue gas itself can be arrived at. This is shown in Table 3.

TABLE 3

Constituent	%	Equivalent in cu. ft.	Equivalent wgt. oz.
H_2O	8·43	8·43	6·77
CO_2	15·52	15·52	30·50
O_2	3·00	3·00	4·29
N_2	73·05	73·05	91·30
Total ..	100·00	100·00	132·86

	Equivalent wgt. lb.	Sp heat per lb.	lb. × Sp heat
H_2O	$\frac{6{\cdot}77}{16}$	0·475	0·202
CO_2	$\frac{30{\cdot}50}{16}$	0·216	0·412
O_2	$\frac{4{\cdot}29}{16}$	0·218	0·058
N_2	$\frac{91{\cdot}30}{16}$	0·244	1·390
Total	8·3		2·062

Therefore 1 lb. of waste gas is equivalent to $\frac{2{\cdot}062}{8{\cdot}3}$ or 0·249 heat units.

From these figures in Table 3, the specific heat of the waste gas is seen to be ·25 B.Th.U. per lb.

To calculate the weight of flue gases produced per hour, the following particulars from the boiler house must be considered.

Inlet boiler temperature = 1,472°F.
Outlet boiler temperature = 455°F.
Fall of temperature (T_2-T_1) = 1,017°F.

Total Heat

Inlet boiler temperature at 1,472°F. and outlet boiler temperature at 455°F. give a temperature difference (T_2-T_1) of 1,017°F. The steam pressure at the time of the experiment was 105 lb. per sq. in. gauge, with a feed water temperature of 100°F. and a superheat of 68°F. These figures show a calculated total quantity of heat of 1,250 B.Th.U. per lb. in the steam. From this must be taken a quantity of (100−32) for the temperature of the feed water giving a net figure of 1,162 B.Th.U. per lb. of steam made. The steam raised per hour according to the steam meter was 2,739 lb., which shows a total amount of heat extracted from the waste gases as 2,739 × 1,162 or 3,182,718 B.Th.U. per hour. The heat absorbed by the boiler is equal to the weight of waste gases, times the fall in temperature (T_2-T_1) through the boiler multiplied by the specific heat of the gases,

$$\text{or } 2{,}739 \times 1{,}162 = W \times 1{,}017 \times .25$$

$$W = \frac{2.739 \times 1{,}162}{1.017 \times .25}$$

$$= 12{,}500 \text{ lb. flue gases per hour.}$$

Where W is the weight of waste gases.

Carbon in Waste Gases

To calculate the amount of carbon in the waste gases, the weight of each constituent in lb. is arrived at by multiplying its percentage by the lb. molecular weight. By taking the total weight of flue gases and calculating the weight of carbon contained in it, the weight of carbon passing out in the flue gases per hour can be arrived at. If the approximate proportion of carbon in the coke charged to the producer is known, the weight of coke consumed per day can be calculated. The calculation of the weight of flue gas is shown in Table 4.

TABLE 4

Constituents in flue gas	Multiplied by lb. Molecular wgt.	Weights in lb.
H_2O	8·43 × 18	152·0
CO_2	15·52 × 44	683·0
O_2	3·00 × 32	96·0
N_2	73·05 × 28	2,050·0
Total weight of flue gases ..		2,981.0

The amount of carbon in 683 lb. of CO_2 is 12/44 × 683 or 187 lb. Therefore, 2,981 lb. of waste gas contain 187 lb. of carbon and 12,500 lb. will contain 187 × 12,500/2,981 or 784 lb. Since the proportion of carbon in coke is about 83%, the weight of coke per hour equivalent to 784 lb. of carbon passing per hour as flue gases through the waste heat boiler is 784 × 100/83 or 945 lb. of coke per hour.

The weight of coke consumed per day will, therefore, be 945 × 24/2,240 or 10.1 tons per day.

B.C.U.R.A. in collaboration with the Boiler Availability Committee, have evolved a dewpoint meter which offers an easy and quick determination of the dewpoint of flue gases from which the quantity of water can be calculated. The instrument is based on the principle that condensation of acid or water films produces an increase in electrical conductivity across a glass surface carrying electrodes. These electrodes are also platinum/platinum-rhodium thermo-junctions. One is circular and the other has its junction at the centre of the circle. The glass detector element is exposed to the hot flue gas and cooled internally by a stream of air directed against the underside of the element. The instrument probe is immersed in the gases and when, by increasing the amount of cooling air, the dewpoint is reached the galvanometer connected to the probe 'kicks'; the temperature is also indicated. A heater is included to bring the instrument up to temperature again when the dewpoint may be checked.

It is unfortunate that the amount of sulphur trioxide present in waste gas has a profound effect on the dewpoint, a few parts per million of sulphur trioxide in boiler flue gas elevates the dewpoint above what might be expected in relation to the water vapour content. The condensate at high temperatures has been found to be strong sulphuric acid, up to 90% under certain conditions.

One may visualise the use of an instrument of this kind for finding the water content of producer gas and waste gas, and by correlating the figures obtained to show the general condition of the retorts and efficiency of the producers. The price of such an instrument is, however, comparatively high (about £300) and until the relationship between dewpoint, dust, sulphur, trioxide and other products of combustion is fully investigated, the expense may not be justified.

Fuel Research Conference

THE Report of a specialist conference on fuel research held in London in July, 1956, has now been published by Her Majesty's Stationery Office. Delegates from official research organisations in the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Rhodesia and Nyasaland, and the Colonies attended the conference which was held under the Chairmanship of Dr. A. Parker, C.B.E., Director of Fuel Research, United Kingdom. By invitation, representatives were also present from other organisations in the Commonwealth interested in fuel research.

The conference discussed existing facilities for training in fuel technology and for carrying out fuel research in the Commonwealth and the possibility of improving and augmenting these facilities. The arrangements made by the first specialist conference on fuel research in 1950 for ensuring liaison, exchange of staff, and exchange of information between fuel research organisations were reviewed. The policy of circulating at regular intervals confidential reviews of progress in selected fields of fuel research was considered a proven success and further topics were added to those originally selected for review.

The possibilities of collaboration between the Commonwealth organisations in investigational work were discussed and arrangements made to initiate joint investigations in the fields of coke testing, coal grindability and petrographical work. To ensure the fullest possible exchange of information between Commonwealth organisations interested in fuel research the conference recommended that state-aided research organisations and nationalised industries actively engaged in fuel research should be invited to participate as full members in future specialist conferences and in activities sponsored by specialist conferences.

Civil Engineering as a Career

THE first-ever comprehensive review of the careers opportunities in the civil engineering contracting industry has just been published by The Federation of Civil Engineering Contractors. Over 9,000 copies are being sent to schools, technical colleges, universities and youth employment offices throughout the country. As is pointed out in this publication, civil engineering contracting is the 'Men at Work' sign. It is the innocent-looking excavation beset with a thousand problems; the labyrinth of mains and drains, ducts and tunnels threaded through the worried earth beneath our cities. It is the industry that moves earth, that fashions in steel and in concrete, in bricks and in bitumen—on exposed headlands, in cramped city sites, nationally, internationally. Civil engineering is the throb of the tractor and excavator, the crane pinpointed to the sky, the gulping pump, the compressor with its noisy family of pneumatic drills, the churning concrete mixer. It is the drainage of the fen, the damming of a mighty river, the thrusting of a harbour into the tempestuous ocean; it is the steelworks, the chemical plant, the power station supported on twenty thousand piles; it is the highway, the slipway, the railway, the runway.

Civil engineering contracting meets the construction needs of transport and communications; fuel and power; public health; industry; and defence. To give a picture of its size, the labour force at home is 250,000 men; the weekly wages bill, over £3 mill.; output per year at home, over £500 mill.; output per year abroad, £80/100 mill.; and degree of mechanisation, probably highest in the world after the U.S.A.

Guide to British Hotels

THE 1958 edition of 'Hotels and Restaurants in Great Britain and Ireland' (the official guide of the British Hotels' and Restaurants' Association) is now being published, price 4s. 6d., post free, 3s. 6d. at most booksellers and at the Association's offices. Last year's edition was a best-seller and supplies were exhausted by March; in consequence this year's printing order has been increased by 33⅓%. The new guide, which covers the whole of the British Isles in greater detail than any similar publication, retains all the popular features of its predecessors. The main section gives full particulars of each establishment, including its size, situation, amenities, and tariff. A distinctive feature of this part is the illustration which accompanies each entry. The guide also contains a series of road maps and a railway map of the United Kingdom, a special map of the London area, mileage tables, main-route diagrams showing distances, and details of ferry services.

Combustion Engineering Association

THE report of the conference on 'N.I.F.E.S. Third Progress Survey,' held by the Combustion Engineering Association at Harrogate last November, is now available. It contains digests of the papers given by Dr. W. A. Macfarlane and Mr. L. Clogg together with summaries of the discussions. A summary of the suggestions made at the conference is included as a separate insert.

D

THE COMPLETE GASIFICATION OF COAL

By F. C. WOOD, Ph.D., M.Sc.

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COMPARED with the manufacture of gas by the more widely established carbonising processes, the total gasification of coal presents several unique features. These are:

(*a*) Gas production is completely separate from coke production. No problem is presented by the balancing of demands for two major products and the process of gas manufacture can be operated under the optimum conditions required for the single product.

(*b*) The gasification of types and sizes of coal which are unsuitable for carbonisation can be undertaken, for example, weakly caking coals and coals of high ash content. Since over half the total coal mined in the U.K. is of the high volatile matter, weakly caking varieties (National Coal Board Coal Rank Code 702 to 902), total gasification processes are potentially of great importance in conserving the dwindling reserves of coking coals for metallurgical coke manufacture. Furthermore, increased mechanisation of coal mining has led, in recent years, to a relatively increased output of fine, dusty coal which is often of high ash content. Total gasification processes offer a means of utilising these coals and, thereby, of contributing materially to the national fuel economy.

(*c*) Total gasification processes are inherently capable of being operated at high thermal efficiency, often in large units of plant. These factors have substantial bearing upon the problem of reducing the cost of gas manufacture.

Developments of gasification techniques, as of any manufacturing process, are closely related to economic trends. As a result the orientation of research into total gasification has differed from country to country, according to the nature of the indigenous fuel resources and national requirements.

Residual Petroleum Products

In this country the principal feature of the post-war fuel situation has been, and still remains, the growing shortage of coal, particularly of the high-grade, gas-making types. Consequently, research has been directed towards the utilisation of other gas-making fuels, for example the use by the British gas industry of residual petroleum products of oil refineries. While a considerable volume of effort has been devoted to research into the use of British coals in complete gasification processes, few commercially significant plants have been erected. In the gas industry, carbonisation remains far and away the largest process of town gas manufacture, as will be seen from Table 1 which is based upon the Statistical Digests of the Ministry of Fuel and Power, 1950-1955.

TABLE 1.—THE RELATIVE THERMAL OUTPUTS OF THE PRINCIPAL GAS-MAKING PROCESSES EMPLOYED BY THE BRITISH GAS INDUSTRY, 1950-1955.

Process	1950	1951	1952	1953	1954	1955
Carbonisation of coal	82·19	83·10	84·24	84·51	82·40	83·84
Gasification of oil	0·12	0·08	0·02	0·02	0·14	—
Water gas manufacture (*a*) ..	16·33	15·47	14·32	14·23	16·32	15·40
Producer gas manufacture (*b*) ..	1·05	1·04	1·04	0·90	0·90	—
Total gasification of coal	0·31	0·31	0·32	0·29	0·23	—
Others	nil	nil	0·06	0·05	0·01	0·76 (*c*)
	100·0	100·0	100·0	100·0	100·0	100·0

(*a*) Blue water gas and carburetted water gas.
(*b*) Excluding producer gas used in gasworks.
(*c*) The breakdown of this figure is not yet available.

The corresponding total makes of the above gases increased from 2,295 mill. therms in 1950 to 2,484 mill. therms in 1955—an increase of 8.24%. When the figures for coke-oven gas purchased by the gas industry are added to the above, the percentage of the total thermal output which is derived from carbonising sources is increased to about 90%.

Despite the lack of any significant trend in these figures, however, it is to be anticipated that any marked further increase in the demand for town gas would have to be met, in part, by the installation of gasification plant.

The important role which total gasification processes are capable of playing in the national fuel economy was recognised and advocated by the Ridley Committee[1] on National Fuel Policy. Paradoxically, the call for developments of this nature has been obscured, to some extent, by the report of a further committee whose concern was the reduction of atmospheric pollution (the Beaver Report).[2] The increased use of solid smokeless fuel recommended by this committee, admirable in itself, requires the installation of further carbonising plant which must again raise the old problem of balancing gas and coke production, even if sufficient coal can be mined to produce all the coke that is advocated. Total gasification processes can contribute materially to the solution of the air pollution problem and research should be directed towards the means of cheapening gas manufacture which these processes offer.

By contrast with the situation in Britain, the influence which has governed the development of total gasification processes in the U.S.A. is the growing need to provide replacements for the dwindling indigenous resources of petroleum and natural gas. In recent years consumption of petroleum and natural gas has increased considerably, and at the expense of coal usage. For example, in 1940 coal provided about 53% of the total energy requirements of the U.S.A. while petroleum and natural gas together contributed 43%. In 1953 the corresponding figures were 33% for coal and 62% for petroleum and natural gas.[3] Several observers have estimated that, if the present trend of demand for petroleum products continues, a proportion of expected demand will have to be met by other resources by 1970. The extensive coal deposits of the U.S.A. furnish the apparent answer to this problem. A major research programme has been carried out by the U.S. Bureau of Mines and others, into means of producing synthesis gas from coal with the ultimate objective of enabling synthetic petrol plants to be built. The production of petrochemicals, hydrogen and alcohol is also envisaged. Methods of total gasification of the coal to produce synthesis gas are the subject of intensive research, since it is estimated that the cost of the manufacture of the gas accounts for about two-thirds of the production costs of the synthetic petrol.

Substantial Item

Despite the continued discovery of new wells and oilfields in America there can be little doubt that, perhaps in the course of two decades, chemicals from coal via total gasification will form a substantial item in the economy of the U.S.A.

The post-war fuel situation in Germany, where much of the pioneer work in the field of total gasification originated, has caused developments there to resemble to some extent those of the U.K., but with notable differences. The rapidly expanding industrial economy which followed the immediate post-war phase of rehabilitation and re-orientation has led to an increasing industrial demand for gas of medium calorific value. In the highly industrial areas such as the Ruhr the output of such gas had hitherto been met almost entirely by the coke ovens and had been determined, therefore, primarily by the demand for metallurgical coke. In Western Germany as a whole, 80% of the total distributed gas is derived from coke ovens, and nearly 90% is used for industrial purposes. Recent developments have been directed towards the replacement of the coke-oven gas used in heating the ovens, since an increased output of available coke-oven gas of about 60%

can thereby be anticipated. Particular attention has been given to the manufacture of the producer gas for this purpose from 'waste' fuels, *i.e.*, fine dusty coals, and it is in the utilisation of these types of coal that the German work resembles, and is of interest in comparison with, British efforts in the same field.

As a further step a large gasification plant using the established Lurgi process was commissioned by Ruhrgas at Dorsten in 1955. Up to 76 mill. cu.ft. of gas are produced per day from 700 to 800 tons of coal. The calorific value of the manufactured gas is raised from about 400 B.Th.U. per cu.ft. to that of coke-oven gas by admixture with up to 20% by volume of natural gas or methane from mine drainage.

The possibility of operating plants for the simultaneous production of gas and electricity has received attention. Gummert[4] has described such a process in which coal is pre-carbonised followed by combustion of the devolatilised coke residue under boilers for power production. This combined process, which is carried out under suspension, could be very attractive under certain economic conditions and the results obtained in the large-scale industrial plants forecast by Gummert are awaited with interest.

In other countries notable commercial developments have taken place which reflect the indigenous fuel resources and economy of the country. In Australia, for example, a large gasification plant was opened by the Duke of Edinburgh in December, 1956. This plant,[33] which operates on the well-known Lurgi principle of oxygen gasification under pressure, is capable of producing 15 mill. cu.ft. per day of town gas from the brown coal which occurs in extensive deposits in Victoria. It is intended to double the capacity of the installation in the near future.

Courageous Venture

In South Africa, where there are extensive deposits of cheap coal but no indigenous petroleum, a plant has been erected for the production of petrol and lubricants from coal via total gasification in Lurgi plant, and synthesis (SASOL).[5, 6] The original scheme anticipated the production of 200,000 tons per annum of liquid fuels, including 55 mill. gal. per year of petrol. Technical difficulties and faults in the installations have delayed full realisation of the potentialities of the plant, which is still working on only half the design rate after 18 months' operation. Considerable interest has been aroused everywhere by this courageous venture and it is fair to state that a full estimate of the economics of the process must await the overcoming of the many initial troubles which have beset the plant.

The growing interest in total gasification processes led to the holding of an International Conference on the subject at Liège in 1954. The papers, which were contributed by authors from many countries, constitute a valuable addition to the literature on gasification. Reference is made to several in the following review.

An outstanding feature of the trend of developments during recent years has been the increasing use made of the relatively new techniques of fluidisation and suspension. Up to 1939 the 'static' or 'fixed'-bed technique was employed for virtually all gasification processes. During the war, however, two developments took place which have had profound influence on the subsequent evolution of the design of plant for gasifying solid fuel. In the United States the technique of fluidisation was applied to the catalytic cracking of oil feedstocks. In Germany synthesis gas plants were built which conducted gasification of brown coal dust both in turbulent boiling beds (the Winkler process) and in suspension (the Wintershall-Schmalfeldt and Koppers processes). In view of the many variations of gasification plant which have originated from these two sources a brief review of the features of the three techniques may be appropriate.

The characteristics of static or fixed-bed gasifiers are well known from the experience of many years of operation with different types. The outstanding feature of the technique is that countercurrent flow of the solid fuel and the gasification medium enables processes based on this principle to be conducted at a high level of thermal efficiency. Moreover, the use of relatively large graded fuel enables the gasifier to be operated at high rates of output without significant loss of coal dust in the product gas. By virtue of the high relative velocities that are permissible between the solid and gaseous reactants the influence of diffusion upon rate of reaction is minimised.

Fixed-bed operation has, however, certain notable disadvantages, namely:

(*a*) A closely graded size of fuel is usually required.

(*b*) When caking coals are used special means have often to be adopted to prevent or to control the agglomeration of the charge as it is heated, relatively slowly, through the plastic range. This aspect is of particular importance when gasification of coal is being conducted under pressure, when the caking tendency is enhanced to a significant extent.

(*c*) Countercurrent flow of coal and gas with its concomitant recuperation of heat leads to the formation of relatively narrow reaction zones in the fuel bed. Since the width of the zone is determined by the thermal capacities of the coal and product gas, on the one hand, and of the ash and gasifying medium on the other, as well as by chemical equilibria and rates of reaction, the permissible rate of gasification in a fixed bed is liable to be restricted by factors such as the ash content of the fuel. In particular, if the ash content is abnormally high, as in washery slacks, it may be impossible to avoid pre-heating the gasifying medium to such an extent that serious clinkering difficulties result. The problems associated with fixed-bed gasification of fuels of this type have been comprehensively discussed by Hubmann and Lange.[7]

In fluidised gasification systems, sometimes referred to as 'boiling beds', the coal is prepared to a relatively fine state of subdivision before being charged to the gasifier. The passage of the gasifying media up through the finely divided particles at velocities within a prescribed range causes the bed to become expanded and turbulent, the particles circulating through the bed in random fashion. Several advantages are frequently claimed for fluidised systems, notably:

(*a*) The entire fuel bed is maintained at a sensibly constant temperature which may be controlled with ease.

(*b*) No restriction is placed upon the rate of reaction or the scale of operation by inability to withdraw reaction heat.

(*c*) The coal particles can be moved from one vessel to another without mechanical means, thereby enabling processes which would otherwise have to be conducted on a cyclic basis to be operated continuously, for example water gas manufacture.

Disadvantages of the technique include:

(*a*) Owing to the sensibly uniform nature of the fuel bed it is not possible to reject ash from the gasifier free from carbon, unless an elaborate multi-stage process is adopted.

(*b*) Entrainment of fine coal from the fuel bed in the product gas can lead to heavy losses of ungasified carbon, particularly as the size and density of the particles of coal diminish during gasification.

(c) It is not possible to force fluidised gasifiers in order to increase output, except at the expense of carbon efficiency. The use of high pressures can overcome this limitation to a large extent.

(*d*) Operation is restricted to temperatures well below the fusion temperature of the coal ash, otherwise agglomeration is encountered.

(*e*) Lack of uniformity of contact between gas and solid due to bubbling, etc., can lead to some by-passing of the gas. As a result unduly deep beds may be necessary, as compared with fixed beds, to achieve adequate contact.

No Bed of Fuel

Suspension gasification systems differ from fixed and fluidised beds in that the fuel particles are completely entrained in, and carried along by, the gasification medium. No bed of fuel, in the conventional sense, exists in gasifiers of this type. The technique may be said to offer the following features:

(*a*) Fine caking coal of high ash content can be utilised.

(*b*) Operation can be conducted at temperatures well above that at which the coal ash fuses. As a result the bulk of the ash may be removed as a liquid slag with comparative ease. The permissible use of very high temperatures also enables fuel of low reactivity to be gasified at high rates since diffusion rather than reactivity is the deciding factor under these conditions.

(*c*) Due to the entrainment of the particles in the gas special means must be adopted to secure adequate relative motion

between the two reactants. This aspect is of great importance in determining the rate of diffusion which, as pointed out above, is the governing influence upon reaction. The tendency for the coal particles to be carried out of the system before they are completely gasified can be very great. Unless adequate turbulence is imposed very large reaction spaces are required.

(*d*) The high temperature of the gases leaving the gasifier is conducive to high heat losses, and the presence in the gases of large quantities of dust makes the problem of heat recovery difficult. If large reaction spaces are used a further serious heat loss may be imposed.

Recent developments in the producer gas field have been concerned mainly with improving the quality of the gas or with enabling caking coal, where available, to be utilised without severe agglomeration. In the first category the work carried out by the British Coal Utilisation Research Association[8] (B.C.U.R.A.) is of importance. It has been shown that high-quality gas can be produced only if adequate attention is paid to the control of the thickness and uniformity of the fuel bed by automatically adjusting the rate of coal feed to suit variations in the demand for gas. Automatic control equipment based upon this principle is now available commercially and should lead to the maintenance of much higher standards of gas quality than have been common in the past.

Thickness of Ash Zone

One feature of producer practice which appears to have received incomplete attention is the automatic control of the thickness of the ash zone, possibly due to the difficulty of selecting a means of control which can compensate for lack of uniformity of the ash layer. An attempt to meet the requirement has been developed in the West's hot gas machine, in which the operation of the ash-removal gear is controlled by thermocouples located in the lining of the lower part of the shell.

A review of the mechanical devices offered by various manufacturers for controlling the agglomeration of caking coal in gas producers has been given by Nelson.[9] Pretreatment of the coal is also advocated, whether by oxidation or thermal means. Experiments are described in which caking coal was successfully gasified in a small producer at the Battelle Institute, U.S.A. The use of an under-feed stoker with co-current flow of coal and air enabled the caking propensity to be destroyed by oxidation of the coal in the combustion zone of the producer. A two-stage experimental producer for use with caking coal is also described, in which partial oxidation and ignition of the coal on step grates in the upper zone furnished a de-caked char which could be gasified without difficulty in the lower zone, although premature carry-over of inadequately pretreated coal fines had occasionally given trouble.

Pioneer work on fluidisation as a technique for the manufacture of producer gas was carried out by Winkler in Germany before the war. Heavy losses of ungasified carbon in the gas and ash led to the conclusion that the process was economically unattractive except where very cheap coal was available. In a later development known as the Flesch-Winkler or Flesch-Demag producer, however, fluidisation has been used in a novel manner to facilitate the discharge of ash from the bed. The Flesch-Winkler producer[10] consists of twin fuel beds which are normally subjected to gasification in down-draught, using coke breeze or small coal. By suitable interconnecting pipework the gas flow through each bed in turn is reversed at regular intervals for short periods. During the up-draught part of the cycle the fuel bed is fluidised with steam, causing the clinker which has formed at the top of the bed to break up and to fall through the bed on to the grate, where it is removed by scraper gear and worm conveyor.

The process is of considerable interest in so far as it enables the gasification of fine fuel to be conducted on the quasi-fixed-bed basis with the corresponding advantages of high thermal efficiency and low dust losses. Operation is unaffected by the fusion temperature of the ash and it is claimed that the process is adaptable to the production of water gas and to pressure operation with oxygen.

The application of the entrainment technique to producer gas manufacture has been investigated both in Germany and in the U.K. At the Fuel Research Station[11] experiments have been conducted over several years with an atmospheric-pressure cyclone-type producer consisting of a 2 ft. diameter by 2 ft. deep water-cooled, refractory-lined, shell. Air and finely divided coal (− 30 mesh) are injected tangentially at the top of the furnace, relative velocity between the reactants being attained by the whirling motion. When operating at temperatures of 1,500°C. and above, liquid slag forms on the walls of the gasifier and is discharged from a central lower tap-hole. The results obtained so far in this cyclone producer are not of commercial significance. The calorific value of the gas made from weakly caking coal has usually been within the range of 50 to 60 B.Th.U. per cu.ft. and gasification efficiency has been restricted by premature removal of carbon from the reaction zone in the gas. Means of improving the carbon gasification by recycling the ungasified residue are under consideration.

Experimental work along somewhat similar lines has been carried out by Ruhrgas using an atmospheric-pressure steam-air blast, preheated to 600°C., in a cyclone producer. The principal differences between this plant and that of the Fuel Research Station are that up-draught is used and a second chamber of increased dimensions is superimposed upon the primary cyclone chamber to enable gasification to proceed to a greater extent.

Following pilot-plant work Ruhrgas have built a commercial unit with a cyclone chamber diameter of approximately 6.5 ft., capable of gasifying 100 tons a day of coal. This plant, which has been described by Nitsler,[12] has been operated successfully for long periods. The dust which is blown out of the producer in the gas amounts to about 30% of the coal charged and contains up to 20% of the carbon in the coal. By recycling the recovered dust to the gasifier the loss of ungasified carbon is reduced to the low figure of approximately 2%. It is stated that this producer has an overall thermal efficiency of 84.2% including 23.2% in steam raised by the hot gas which has a calorific value of 110 to 130 B.Th.U. per cu.ft. The cost of the gas produced is 12% less than that of gas from conventional producers, or, if credit is allowed for the steam raised, 28% lower.

Several proposals have been made for enabling fine coal to be gasified by injection through tuyères into a producer operating under non-suspension conditions. In one the proposal is to inject the fines into the fixed bed of a slagging producer which contains large coke. Problems which must arise in the development of a proposal of this nature include the design of tuyères capable of withstanding the high temperature of slagging operation and means of ensuring adequate penetration of the bed by the blast and its uniform distribution therein.

Problems Encountered

The second proposal, which forms the basis of the Rummel producer,[13] is to gasify the fines by injecting them with preheated air and steam into a slag bath maintained at a high temperature. The removal of ash is accomplished by overflow from the slag bath. Problems which are encountered in this producer include the attainment of adequately high preheat temperature for the reactants—usually obtained by Cowper stoves—as well as that of securing uniformity of distribution. The process is capable of producing water gas by dividing the bath vertically into combustion and steaming zones. Although no detailed results have been published on the operation of Rummel producers it is believed that their specific output (*i.e.*, volume of gas/volume of reaction space per unit time) is appreciably higher than that of conventional producers.

Cyclic operation of a gasification process is usually adopted to enable gas of higher calorific value to be obtained than is possible in producers, by separating the steam reaction of the fuel from that of the combustion stage. When coal is gasified in cyclically operated plant the operation is often complicated by the necessity for avoiding excessive loss of volatile matter during the blow part of the cycle. Interest in the use of coal in this type of plant has been heightened in recent years by the desirability of conserving stocks of gas coke for the domestic market.

About 8% of the total coke made in gasworks is normally used for C.W.G. manufacture. In order to reduce this figure and, at the same time, to enable the gas industry to make use of coals which cannot be carbonised, trials have been conducted over a number of years into the use of low-volatile

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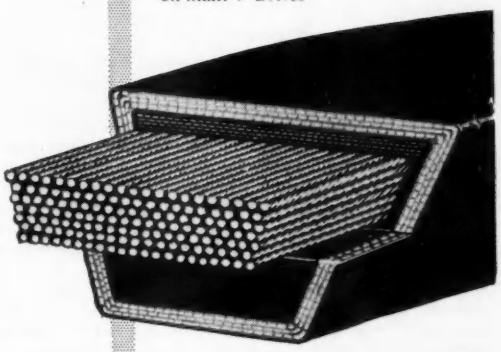

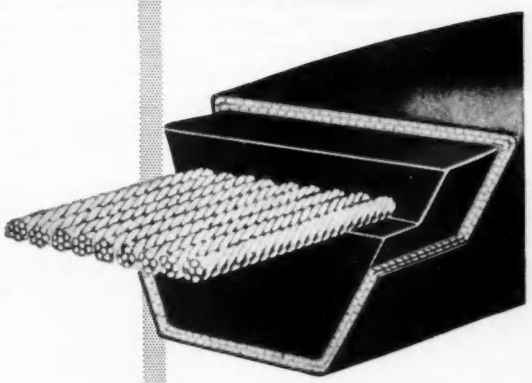

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matter (12 to 14%) weakly caking coals (Coal Rank Code 200). Greater interest lies in the utilisation of high V.M., weakly caking coals (Coal Rank Code 700, 800 and 900), since these are more widely available. The subject has been reviewed by King[14] who mentions full-scale trials of these types of coal in conventional C.W.G. sets by the East Midlands Gas Board. Although not in itself the immediate concern of this review, the work carried out by the Gas Research Board[15] on the influence of preheating the air and steam supplies to water gas set is of importance. It was shown that, by preheating the air and steam to 400°C. with the product gas, increased output and yields of gas were obtained.

In order to overcome the disadvantages associated with the use of coal in standard water gas sets several processes have been developed specifically to gasify coal in steam under cyclically operated conditions. The gas so obtained is often called 'bituminous' water gas to distinguish it from water gas derived from coke. In its simplest form the coal-steam gasifier comprises an upper retort section superimposed on a water gas generator. The sensible heat in the gases from the lower fuel bed is used to distil the coal charge during its passage down the retort. Processes of this type which have been applied commercially in recent years include the following:

(a) G.I. (Gaz Intégral) Process.

In the G.I. version of the two-stage water gas process the carbonising section of the generator is a refractory retort built upon a water-jacketted gasifier and divided by hollow refractory radia-vertical partitions into four compartments. The blow gases from the gasifier pass up through flues in the radial and peripheral walls, providing sensible heat for the distillation of the coal, and are then burnt in a chequer-brick superheater, combustion chamber and waste-heat boiler. The steam supply is preheated in the superheater before entering the base of the gasifier via a mechanically operated dry-bottom grate.

The nature of the gas produced in G.I. plant obviously depends to a large extent upon the type of coal used. Spaggiara[16] has described the results of trials with an East Midlands coal (34.2% V.M., Crucible Swelling No. 1) in a G.I. plant at Rome. The gas produced had a calorific value of 335 B.Th.U. per cu.ft. and would be suitable for the dilution of retort gases or for enrichment by oil carburetting to town gas standards.

Several G.I. plants have now been erected in Britain. As with most fixed-bed gasifiers graded fuel, preferably 1 in. to 2 in., is required for optimum operation of these units.

(b) Power-Gas Two-Stage Process.

A similar type of total gasification plant developed by the Power-Gas Corporation has been described by Embling.[17] A unit which is capable of producing 2 mill. cu.ft. per day of gas of 326 B.Th.U. per cu.ft. from weakly caking West Midlands coal (V.M. 36.3%, B.S. Swelling Index 1½), has been commissioned at Watford.[18]

Several Investigations

The fluidised solids technique, with its facility for avoiding the cyclic operation necessary for fixed beds, has attracted several investigations into the manufacture of water gas from coal. Processes have been proposed, among others, by Esso, I.C.I.[19] and the Fuel Research Station.[20] It is not proposed to deal with these in detail here, since the results have generally proved disappointing and are of interest mainly in that they demonstrate the limitations of the fluidised solids technique under the conditions used in these processes. While the first two versions of the process rely upon the circulation of a coke burden between combustion and steaming stages, the third process is novel in that heat is transmitted indirectly from the former stage to the latter via an intervening partition, on both sides of which are the fluidised beds.

The results of pilot-plant work published by I.C.I. and the Fuel Research Station are corroborative and, in particular, the conclusions reached were as follows:

(a) Due to the restriction of the steam velocity through the fluidised beds and to the operation at low pressures, the rate of carbon gasification was very low campered with fixed beds, typically 20 to 30 lb. per sq. ft. per hour.

(b) 20 to 25% of the carbon in the coal was carried out of the plant unreacted, owing to the progressive diminution of the particle size and density by gasification.

I.C.I. proposed to utilise the heavy carryover from the combustion vessel by burning the entrained burden under boilers, but it is clear that the percentage of carbon to be disposed of in this fashion would raise more steam than can be used in the gasification process. An interesting observation made during these trials was that pulverised coal, even of the strongly caking variety, could be injected directly into the hot fluidised coke bed without agglomeration.

The principal conclusions which can be drawn from these various investigations, in the author's opinion, are: First, for fluidisation to be successful as a technique of gasification it must be applied under pressure, in order to compensate for the low specific outputs associated with fluidising velocities by the high outputs which pressure operation permits. Secondly, if a high degree of carbon gasification is required, multi-stage operation is necessary in order to avoid the rejection of a high proportion of carbon with the ash. Dent has suggested that it may be desirable to submit the withdrawn residue to suspension gasification to clean up the carbon content.[21]

An important objective of any total gasification process for the production of gas of medium or high calorific value must be to secure enrichment of the gas to the required standards of distribution, usually 450 to 500 B.Th.U. per cu.ft. in this country and about 1,000 B.Th.U. per cu.ft. in the U.S.A. Unless recourse is made to external enrichment by oil it is necessary to reduce gaseous hydrocarbons, especially methane, during the gasification process.

Still Rather Low

The Lurgi process of total coal gasification, developed in Germany well before the war, secured enrichment by the use of gasification pressures of the order of 20 to 30 atmospheres, coupled with a continuous steam/oxygen blast. Under these conditions methane is formed in the fuel bed by direct hydrogenation of the volatile matter and, to a lesser extent, of the fixed carbon of the coal. The washed and purified gas has a calorific value of 400 to 440 B.Th.U. per cu.ft., which is still rather low by British standards. It is remarkable that this Lurgi process, which pioneered the principle of oxygen gasification of coal under pressure, should remain almost the sole commercial example of the principle, despite the intensive work carried out by the Americans and others in this field. After 25 years of commercial operation the Lurgi process probably still offers the cheapest method of making gas of medium calorific value on a large scale.

Improvements which the Lurgi Gesellschaft have introduced into the original process have been described by Hubmann.[22] They include means for enabling caking coal to be used and for securing increased gas output, leading to reduced capital and operating costs. Lurgi producers of up to 12 ft. diameter are now in operation, capable of gasifying 400 tons of coal a day under a pressure of 370 p.s.i.

Recent work on the use of British coals in a pilot-scale Lurgi gasifier has been carried out by the Gas Council.[23] Particular attention has been given to means whereby the methane content of the gas can be enhanced to give a calorific value acceptable by British standards; for example, by lengthening the fuel bed to give longer time of contact. The use of a deeper fuel bed is desirable also in that it improves the thermal efficiency of the process by increasing the extent of the steam decomposition. The work is being extended to include a study of the use of mechanical devices for controlling the caking of the coal—a property which is enhanced by pressure—and the operation of the gasifier under slagging conditions.

The mechanism of methane formation in fuel beds being gasified under pressure was elucidated by Dent and his co-workers almost 20 years ago. Based on this knowledge the proposal was made to split the fuel bed of a Lurgi gasifier into two distict countercurrent stages, gas from the lower part of the bed being withdrawn for removal of carbon dioxide and undecomposed steam before re-admitting the gas to the upper section of the gasifier. The increased partial pressure of the hydrogen in the Lurgi gas obtained by this intermediate washing and cooling procedure should enable enhanced yields of methane to be obtained from the limited hydrogenation of coal and volatile matter in the upper section

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of the fuel bed, providing a gas of calorific value conforming more closely to the standards of British town gas.

Laboratory work carried out by the Gas Council has shown that the fluidised-solids technique is capable of providing the close control over operating conditions which is necessary for high yields of methane to be obtained via hydrogenation of coal. As a result the proposal has been made to carry out the two-stage gasification process described above under fluidised conditions.[21] A preliminary study of the hydrogenation stage of the overall process has been made in a ½ ton per hour pilot plant operating at pressures of up to 25 atmospheres. In particular it was concluded that multi-stage fluidised beds must be used, with countercurrent flow of the coal and the hydrogenating gas, if the two objectives of high yield of methane and high calorific value are to be attained simultaneously.

Low Conversion Efficiencies

Direct hydrogenation of coal to gas of calorific value of 900 to 1,000 B.Th.U. per cu.ft., while theoretically possible and, indeed, already achieved in the laboratory, is not economically attractive in the present state of practice owing to the law carbon conversion efficiencies associated with the production of such gas. The alternative method of enrichment which has been considered is catalytic methane synthesis from Lurgi-type gas but the process suffers from the drawback that a lower output of gas is obtained and the overall thermal efficiency is lower. Recent work by Dent and others[24] has shown that a more attractive means of enriching Lurgi gas to these high calorific values may be obtained by hydrogenating oil under conditions which are broadly comparable with those obtained in the coal hydrogenation process, *i.e.*, pressures of 10 to 50 atmospheres and temperatures of about 800°C. in fluidised beds of coke. Almost the entire range of petroleum oils has been converted to gas under these conditions in a pilot plant producing ¼ mill. cu.ft. per day. As compared with the alternative method of enrichment by methanation the output of gas is increased by 30 to 50%.

The various methods available for the production of high B.Th.U. gas from coal with particular reference to conditions in the U.S.A. have been reviewed by Newman and Pipilen.[25] They stress the merits of coal hydrogenation as compared with methane synthesis to the extent of advocating that the calorific value of distributed gas in America should sooner or later be reduced to a level at which hydrogenation of coal can be adopted, as a means of replacing the diminishing resources of natural gas. The authors point out that the thermal carrying capacity of existing distribution networks is almost the same for hydrogen-methane mixtures as for natural gas, the lower specific gravity of these mixtures compensating for the lower calorific value.

A novel process for the production of town gas by gasification of powdered coal without the use of oxygen or high pressures has been tried out on the pilot scale by Ruhrgas in conjunction with Lurgi (L. R. Process).[26] Coal dust is injected, usually with steam as the gasification medium, into a reactor which is filled with a downwardly moving bed of hot pebbles. The fine coal is carbonised and partly gasified under these conditions to produce a gas of about 420 B.Th.U. per cu.ft. calorific value (when using a gas coal). The heat requirements of the process are provided by preheating the recycled pebbles in a heater which is fired with producer gas, this gas being manufactured from the coke dust which is recovered from the hot town gas leaving the reactor.

No detailed operating figures are yet available.

In synthesis gas manufacture the objective is the production of a gas as rich in hydrogen and carbon monoxide as possible; from the viewpoint of chemical equilibrium it is permissible to carry out the gasification at very high temperatures, there being no restriction imposed by the need to produce gaseous hydrocarbons as where town gas is required. As a direct result the suspension technique of gasification, with its adaptation to high temperature and slagging operation, is peculiarly suited to the production of synthesis gas.

Since the cost of the synthesis gas is about two-thirds of that of synthetic petrol from coal, the work of the U.S. Bureau of Mines in this sphere has been directed mainly towards cheapening the cost of synthesis gas manufacture. This object has been pursued in two principal directions, namely, oxygen gasification of the coal, and the use of high gasification pressures. By conducting the gasification at the pressure required by the synthesis process approximately two-thirds of the compression charges incurred by synthesis from gas produced at atmospheric pressure are avoided.

Following early work in an atmospheric-pressure pilot plant which used highly superheated steam without oxygen the U.S. Bureau of Mines has now developed a suspension gasifier capable of operation at pressures of up to 450 lb. per sq. in. gauge.[27]. Powdered coal (90% −200 mesh) is injected downwards with preheated steam and oxygen into a narrow vertical refractory chamber. Below a water-cooled waist the chamber opens out into a second chamber in which the gasification of powdered coal is completed in the very short time of 1 to 2 seconds. By using a high ratio of oxygen to steam gasification is conducted at high temperatures at which the coal ash is fused and partly frozen on to vertical water-cooled walls. After building up an equilibrium thickness of frozen slag in this manner the molten slag is quenched by a water spray at the base of the chamber and removed via a lock hopper and let-down valve. It has been reported that 88 to 93% of the carbon is gasified and that 20 to 30% of the coal ash is recovered as slag. The remainder of the ash, which contains the ungasified carbon, leaves the gasifier in suspension in the product gas and is scrubed out under pressure. It is claimed that the system permits of good waste-heat recovery and that no great problem is presented by refractories inasmuch as the frozen slag protects these from erosion and attack. It is, however, admitted that the thickness of frozen slag as formed is critical and that difficulty may be experienced in gasifying coals of different ash contents and compositions unless the reactor is modified to suit each coal. The high volumetric capabilities of this type of gasifier command attention, gasification rates of up to 800 lb. coal per hour per cu.ft. of reaction space being reported.

Similar Approach

A similar approach to the problem has been made by the Institute of Gas Technology, which has built and operated a cyclone-type suspension gasifier for use with steam and oxygen at pressures of up to 100 p.s.i.,[13], and temperatures of up to 1,650°C. The principal differences from the Bureau of Mines gasifier were:

(*a*) Tangential injection of the steam and coal; axial injection of oxygen.

(*b*) Refractory-lined walls; no water cooling.

In comparison with the performance of the Bureau of Mines pressure gasifier the volumetric output is low—typically 50 lb. per hour per cu.ft. at 100 p.s.i., and the steam requirement higher.

The possibility of utilising the heat released by fissionable material for providing the heat requirements of the steam-carbon reaction has been recognised by several observers. It is obvious that many problems difficult to solve would be associated with the design and operation of nuclear reactors at the high-temperature level at which the steam-carbon reaction could be used as coolant, *e.g.*, slag attack or erosion of the atomic fuel elements, to mention only one. Preliminary work on the elucidation of this and other problems has been announced by the U.S. Bureau of Mines.[28]

Koppers-Totzek

While most of the American work on synthesis gas manufacture is experimental, a commercial plant has been erected by Du Pont de Nemours at Belle, W. Virginia, for hydrogen-ammonia production. The design of this plant is based upon the early U.S. Bureau of Mines experience with atmospheric-pressure synthesis gas generators mentioned above.

Another powder-gasification process which has been developed commercially during recent years is the Koppers-Totzek.[29] Powdered coal, steam and oxygen and low-pressure operations are used in this process also, but a horizontal gasifier is employed. The turbulence necessary for a high rate of gasification is secured by injecting the mixed reactants at opposite ends of the chamber. Part of the ash is collected in hoppers located beneath the central portion of the gasifier. Pilot-plant work in a 1 ton per hour unit of this type was carried out by the U.S. Bureau of Mines, but the poor gasification efficiency and difficulty of recovering the ash led to their abandoning the process. Commercial units have been operated in Finland and Japan, and it is considered that improvements in performance

over that of the earlier gasifiers of this type have established the process on a sound basis.

The Finnish plant has been described by Osthaus.[20]. A carbon gasification efficiency of 88.6% is stated, when producing a synthesis gas of 85.1% (H_2 + CO) from coal containing 16 to 19% ash (dry basis) in two gasifiers, each of which is rated at 50 tons per day throughput. Sixty-seven per cent. of the potential heat of the coal appears in the gas, or 75.5% if credit is given for steam generated by waste-heat recovery. It is estimated that about 30% of the pulverised coal escapes ungasified, even with recirculation of one-third of the dust burden, but much of the potential heat in the dust is recoverable by burning it under coal driers, etc. Gasification rates of 3,000 kg/m³ per hour (=187 lb. per cu.ft. per hour) are claimed, which compare very favourably with the output of the U.S. Bureau of Mines atmospheric suspension gasifier.

Fluidised feeders for suspension gasifiers have been used successfully by the U.S. Bureau of Mines,[21] but these have the disadvantage of needing very large pressure vessels for the feeder. Proposals to pump the coal in the form of a water slurry have been made[22, 12] and some results at 600 lb. per sq. in. gauge operation are reported. It would appear that a coal:water weight ratio of 1:1 is required for adequate operation of the pumps whereas gasification of the coal requires only about 0.3 lb. steam per lb. of coal. The problem of recovering the excess water between the feeder and the gasifier does not appear to have been solved.

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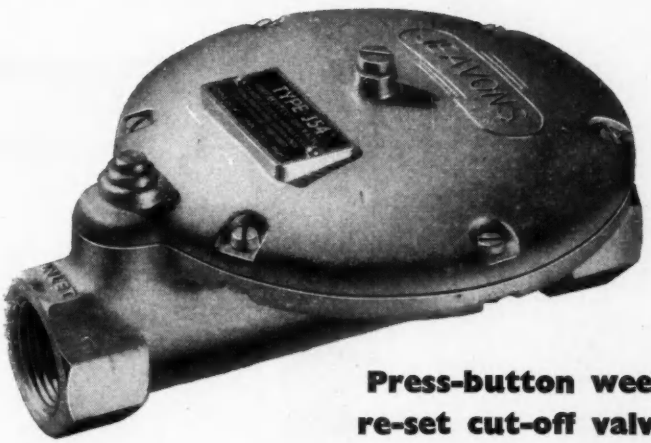

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